SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1907.

GENERAL PHYSICS.

1276. *Measuring Balloon Records.* **K. v. Bassus.** (Beiträge z. Physik d. freien Atmosphäre, 2. p. 73, 1906. Abstract by **A. Schmidt.** Zeitschr. Instrumentenk. 27. pp. 201–202, June, 1907.)—The apparatus is especially adapted to the baro-thermo-hydrograph of Hergesell and Bosch, and is to facilitate the exact determination of corresponding points on the four or five curves of a diagram. The time abscissa can be measured within ± 0·06 mm. The frame of a mirror can be moved along an alidade in the direction of the abscissa; the pivots of the pointers for the base lines are adjustably fixed in a slot of one of the sides of the frame, and each pointer carries at its end a diopter with fine quartz thread. H. B.

1277. *Compressibility of Water fo1 Hydraulic Presses.* **v. Roessler.** (Stahl u. Eisen, 27. pp. 808–809, June 5, 1907.)—The author shows that in large presses the compressibility of the water is not negligible. The change of volume of the water due to compression may be much greater than that of the cylinders and pipes containing it, due to the pressure. A 2,500-ton press is considered numerically, taking the average compressibility of the water as 48×10^{-6} between 1 and 800 atmos. The compression of volume of the water in the system was equal to $\frac{1}{8}$ of the volume of one stroke of the pump, whilst the increase of volume of the cylinders and pipes was $\frac{1}{17}$ of the compression of the water, the stretching of the press columns corresponded to $\frac{1}{71}$, and the bending of the crosshead to $\frac{1}{16}$ of the compression of the water. F. R.

1278. *Determination of Mineralogical Hardness.* **H. Z. Kip.** (Amer. Journ. Sci. 24. pp. 23–32, July, 1907.)—Discusses the question of the definition and measurement of hardness. The resistance to abrasion of their surfaces is defined as the hardness of bodies. This is regarded as being overcome by a force whose components, x normal, and y parallel, to the surface have minimum ("critical") values for each substance. Hardness is to be determined either (1) by observing the minimum force, $\sqrt{(x^2 + y^2)}$, necessary to produce abrasion, or (2) by observing the work expended in producing a given amount of molecular dislocation. The hardness found by method (1) may be verified as follows for two minerals a and b. Pass the abrading point over a, through a distance p_a, under critical pressure x_a, already determined, and over b, under the critical pressure p_b, through a distance $p_a \sqrt[3]{(\text{density of } a/\text{density of } b)}$; the weights of material abraded should be proportional to the molecular weights of the minerals. The chief difficulty in applying this method lies in our frequent ignorance of the physical molecular weight. An apparatus for determining x and y is described. The force required to pull the specimen along under a diamond loaded with a known weight is directly measured. The minimum load necessary in order that there may be scratching is also found by trial. Results obtained are to be published later. F. R.

1279. *The Brinell Hardness Test.* **J. E. Stead** and **T. Greville-Jones.** (Eng. Rev. 17. pp. 54–55, July, 1907. Abstract of paper read before the Cleveland Inst. of Engineers.)—Describes the small press specially constructed for this test by the Aktiebolaget Alpha. The following hardness numbers are given, the pressure used being 3,000 kg., and the diam. of ball 10 mm.

Clarence Pig-iron.	Hardness Number.	Foundry Mixtures.	Hardness Number.	Miscellaneous.	Hardness Number.
Glazed iron...	143	No. 4 foundry	131	Spiegeleisen, 10 per cent. Mn	782
No. 1	104	Ditto	143	Chilled casting, hard face.............	445
No. 3	112	Ditto	143	" " , middle mottled	350
No. 4 foundry	156	Ditto	153	" " , grey back...............	207
No. 4 forge...	160	No. 4 forge ...	170	Hardened steel file	560
Hard forge...	197	Ditto	187	Horseshoe magnet, magnetised part	512
Grey mottled	153	Broken motor cylinder......	207	" " , soft part	207
White	418			Rail steels, 0·4 to 0·45 per cent. C. ...	200 to 210
				Tin-plate bars, 0·1 per cent. C..........	112
				Purest Swedish iron	87

F. R.

1280. *Recovery of Nickel and Carbon Steels from Overstrain.* **E. L. Hancock.** (Phil. Mag. 13. pp. 688–693, June, 1907. Paper read before the Indiana Engin. Soc., Jan. 18, 1907.)—The results of tests in tension, torsion in one direction, and torsion first in one direction then in the opposite, whilst generally in agreement with Muir's results [see Abstract No. 837 (1906)], show also the corresponding properties for a 3·5 per cent. nickel steel. A mild steel and the nickel steel experimented upon were of similar composition, except as regards nickel. The loss and recovery of elasticity in torsion are very similar to those in tension and compression. The carbon steel seems to recover more rapidly than the nickel steel; this point, however, was not conclusively settled. Recovery from tensile overstrain was not aided by agitation by blows from a light hammer. Elasticity was in all cases restored by rest or by a brief immersion in boiling water. F. R.

1281. *Properties of Portland Cement.* **H. Burchartz.** (Königl. Materialprüfungsamt, Mitt. 25. 2. pp. 62–82, 1907.)—The following properties of 100 samples of cement are correlated: Weight of a litre poured and shaken, sp. gr. air-dried and ignited, time of commencing to completion of setting, rise of temperature, permanence of volume, fineness of grinding, water required for normal consistency, tensile and compressive strength. There appears to be no definite relation between the weight in bulk, sp. gr., loss on ignition, fineness of grinding, or time of setting, and the strength of the cement; nevertheless low weight in bulk, and low sp. gr., with high loss on heating and high residue on a 5,000 mesh per sq. cm. sieve, are accompanied by moderate strength. But these quantities are also to some extent interdependent; *e.g.*, the greater the loss on ignition the less the weight in bulk, and the sp. gr. in the condition in which the cement is received. In general, tensile strength and compressive strength increase or diminish together, though not in a fixed ratio. The average increase of strength in the period from the seventh to the twenty-eighth day was for tensile 5 (0·5 to 9·4), and for compressive strength 80 (42 to 182) kg. per sq. cm. The limiting values of the components, from the analyses of cements, are given in a table. For the complete data the original paper should be consulted. F. R.

1282. *Proportioning Concrete for Maximum Strength and Density.* **W. B. Fuller** and **S. E. Thompson.** (Amer. Soc. Civ. Engin., Proc. 33. pp. 222-298, March, 1907. Eng. News, 57. pp. 599-601; Discussion, pp. 601-602, May 30, 1907. Abstract.)—Crushed stone was graded through twenty-one sieves, from 2½-in. mesh downwards. The proportions left on each sieve are plotted for a variety of stones. The stone in each experimental concrete consisted of a mixture of all sizes below the given maximum, in the proportions found by the trial, *i.e.*, of all material passing a mesh of given size. Some of the more important conclusions follow. The larger the maximum size of stone the stronger the concrete in both compression and bending and the denser the concrete. Gravel gives a denser concrete than broken stone, and sand gives a denser concrete than stone screenings of similar size. Concrete of broken stone is stronger than concrete of gravel, though less dense; if, however, rounded sand be used the gravel concrete becomes stronger. Aggregates of particles specially graded to give, upon addition of cement and water, a mixture of maximum density, produce a concrete of greater strength than a mixture of ordinary materials with the same proportion of cement. The gain of strength by these means under the conditions of the tests was about 14 per cent.; or the best artificially graded aggregate requires about 12 per cent. less cement than an ordinarily selected aggregate for the same strength. Strength and density are affected more by variation of the diameter of sand particles than of stone. It is shown, for the materials experimented with, though it is admitted that confirmation of so important a law outside the limits of the tests is necessary, that the correct mode of proportioning concrete for strength consists in finding, with any percentage of cement, a concrete mixture of maximum density, and varying the proportion of cement to fine particles in the sand. In practical proportioning, with a given sand, stone, and percentage of cement, the strongest mixture is attained when the volume of the mixture, sand, cement, and water, is just sufficient to fill the spaces between the stones. The curve relating the percentage passing a given sieve and the size of mesh ("mechanical analysis curve") resembles a parabola in the case of the best mixture of cement and aggregate. The rate of flow of water through concrete decreases with increase of the percentage of cement (rapidly), with increase of the maximum size of stone, with age of concrete, with decrease of the head of water (nearly uniformly), and with increase of the thickness of the concrete (rapidly). Concrete of sand and gravel is less permeable than concrete of stone and stone screenings; *i.e.*, for equal permeability slightly less cement is required with gravel than with broken stone. The ordinary variations in the amount of water used do not very materially affect the volume of the concrete. In the *discussion*, **J. L. Davis** gave examples of the application of the principles put forward by the authors to practical proportioning of concretes, which makes their utility and the method of handling them obvious. F. R.

1283. *Report of the Reichsanstalt for* 1906. (Zeitschr. Instrumentenk. 27. pp. 109–124, April; 147–160, May, and pp. 184–200, June, 1907. Extract from the Report of the Kuratorium der Reichsanstalt, March, 1907.)—The following are some of the more important matters investigated during the period covered by the Report; for statistics of tests and all details and references the reader must refer to the original Report. *Elastic Properties of Cast Iron.* [See Abstract No. 8 (1907).]—Comparisons of results obtained with widely different ranges of stress show that a formula of the type $E = d\sigma/d\epsilon = E_0 - c\sigma$ (where E is the modulus of elasticity, σ the stress, and ϵ the lineal extension) fits the experimental results satisfactorily, while the exponential formula of Schüle ($\epsilon = a\sigma^m$, where a and m are constants) breaks down for small extensions. It is found that white cast-iron has a much higher modulus of elasticity than grey iron, and the difference is ascribed to the presence of graphite and the looser structure found in grey iron. Heating and quenching grey iron, while resulting in great hardness, lowers the value of E still further, although this value shows signs of recovery with time. *Elastic Afterworking.*—This property has been studied in several series of alloys, and definite minima have been discovered; it is intended to coordinate these results with those of thermal and micrographic analysis. An alloy particularly free from this property is that of Au 86 and Cu 14 per cent., which would be suitable for use in suspensions. Direct comparisons of the platinum–platinum-rhodium thermo-junction with the air-thermometer up to 1,600° C. have been made [Abstract No. 80 (1907)]. The setting process in various forms of masonry has been further followed. Cement mortars, even when they contain only small proportions of cement, show continued changes of dimension even at the end of two years. Lime mortar containing sand shows a marked change about five months after use, but these changes die down towards the end of the second year. *Electricity.*—Tests of the constancy of the standard manganin resistances show no serious variations, and the mean values of the standards remain unaltered. Investigations of mercurous sulphate for standard cells have been carried further, and it has been found that when coarse-grained preparations were made, the e.m.f. effect was always the same when reagents of the same degree of purity were employed, the temperature at which the precipitation was made having no effect on the electrical activity of the salt while materially affecting its colour; on the other hand, large departures from the normal electrical behaviour were found when sulphuric acid, said to be pure, was employed which contained considerable traces of dissolved lead sulphate. The formation of ozone and the oxidation products of nitrogen produced by the silent electric discharge have been studied [Abstract No. 920 (1907]. Further spectroscopic work with instruments of very high resolving power has been carried out, the results affecting the views as to the structure of the spectra of certain substances, notably mercury [Abstracts Nos. 518, 1395 (1906) and 849 (1907)]. The great resolving power of these instruments has also rendered available means for studying the Zeeman-effect in weak magnetic fields, in which many of the anomalies found in strong fields disappear. The construction of a new and more accurate scale of the wave-lengths of Frauenhofer's lines is contemplated. Anode rays formed by anodes consisting of hot salts have been studied [Abstracts Nos. 96, 869 (1907)]; these rays carry a positive charge and excite fluorescence on striking solid bodies; in high vacua the path of the rays is not visible, but in lower vacua a bushel of light is seen proceeding from the anode, this light showing the line-spectrum of the metal ions present in the salt in question. The further investigation of these phenomena is of interest in connection with flame-arc lamps. *Magnetic researches* on the properties of various kinds of iron and steel have been continued on the lines of the last report, various methods of measurement being studied in detail. The effect of annealing at various temperatures on the magnetic properties of commercial materials has been studied, special care being taken to prevent oxidation during the annealing process. An attempt is being made to correlate the magnetic properties with the microstructure of the materials, while the annealing temperatures have been chosen with reference to the critical ranges of the various kinds of steel used. *Optical pyrometry* has received much attention. Sources of error in the Wanner pyrometer, which are unimportant for industrial purposes but become serious when the instrument is employed for accurate measurements, have been studied and found to lie chiefly in the fact that the small electric lamp is used at full pressure and thus rapidly alters; the check on the electric lamp by means of the amyl-acetate standard lamp is inadequate on account of the interposition of a piece of ground glass, which is apt to vary both from one instrument to another, and also at different times with the same instrument. Improvements overcoming these sources of error for accurate work have been devised. The melting-points of Seger Cones have been further investigated, and those of cones Nos. 4 to 18 have been determined; in this range the values assumed for industrial purposes were found to be within 25° C. of the correct values, but at higher temperatures much more considerable divergences probably exist. The various cones were found to differ very considerably in respect to the definiteness of their indications: thus cone 14 always gives accurately the same softening temperature, while in the case of No. 12, differences up to 40° C. were observed. In making these observations the rate of rise of temperature had to be very carefully watched, as the cones are very sluggish in their behaviour. In connection with photometric work, attention is directed to the fact that various sources of illumination can only be adequately compared when their mean spherical c.p. is determined, the very varied forms of modern illuminants rendering this consideration especially important. Other investigations dealt with the accurate measurement of plane glass plates with a view to detecting gradual changes, measurement of strains in optical glass by the aid of polarised light, the weathering of optical glasses as detected by the application of the iod-eosin test to fresh fractured surfaces, the action of alkaline fusions on platinum, and the improvement of recipes for producing coloured protecting coatings on metals, as used in instrument-making. A list of the publications by the Reichsanstalt and by members of the staff is given. W. Ros.

1284. *Resistance of Air.* **A. Mallock.** (Roy. Soc., Proc. Ser. A. 79. pp. 262–273, June 8, 1907.)—Most of the work, both theoretical and experimental, which has been done on this subject may be divided into two classes, one of which comprises all the results having reference to such moderate velocities as can be obtained with artificially-produced currents (*i.e.*, up to about 100 ft. per sec.), while the other is confined to velocities about and exceeding the velocity of sound. Between these two there is a gap of nearly 1,000 ft. per sec. It is the object of the present paper to find an expression which will represent the resistance generally. The resistances considered are those of bodies which form a wake, made up of a complex system of eddies whose formation requires a continuous expenditure of work. The formation of these eddies is discussed with the aid of diagrams, both for two- and three-dimensional cases. The motion of the fluid in the wake is so complicated that it seems hopeless to treat it mathematically except in a statistical manner, and even for this data are at present wanting. It is known, however, that for low velocities in air the pressure on the hind surface of a plane is less than the general pressure in the fluid by about half the excess of pressure on the front surface. As the speed increases and approaches the velocity of sound the negative pressure increases, and when the velocity reaches about 2,400 ft. per sec. (in air) the negative pressure is equal to one atmo., and the hind surface is covered by a vacuum. From consideration of Boys' bullet photographs and the foregoing, it appears that the resistance of a body moving in a compressible gas may be represented as the sum of three terms, namely: (i.) the positive pressure (X) on the head (treating the fluid as incompressible); (ii.) the negative pressure (Y) on the tail; (iii.) the force (Z) necessary to generate the waves. From experimental results at velocities over 2,400 ft. per sec., the author finds that for a pointed projectile the resistance is fairly well expressed in c.g.s. units by the equation—

$$R = \tfrac{1}{4}\rho_0\tfrac{1}{2}v^2 + (1-A)^{0\cdot854} + 1\cdot35 \times 10^{-7}(v'-a)^2,$$

the corresponding equation for flat heads being—

$$R = \rho_0\tfrac{1}{2}v^2 + (1-A)^{0\cdot854} + 7\cdot5 \times 10^{-7}(v'-a)^2.$$

Here ρ_0 = density of undisturbed air, $A = \left(1 - \frac{\gamma-1}{2}\cdot\frac{v^2}{a^2}\right)\gamma/\gamma^{-1}$, v' = velocity of sound in the air just in front of the projectile, and is equal to v when v' is $> a$, the velocity of sound in still air. The curves resulting from these two equations are shown to agree well with experiment. A. W.

1285. *Projectiles in Air.* **A. Mallock.** (Roy. Soc., Proc. Ser. A. 79. pp. 274–276, June 8, 1907.)—A remarkable feature of the resistance curve [see preceding Abstract] of a pointed projectile is that for velocities from 1,100 to 3,000 ft. per sec. it is almost a straight line which, if produced, would cut the axis of abscissæ at about $v = 850$ ft. per sec. The equation of this line is $R = 2\cdot53\,(v - v')$, where R is the resistance in lbs. per sq. ft. of cross-sectional area, the velocities being in ft. per sec., and where $v' = 850$ ft. per sec. The retardation (f) of the shot is given by $f = (2\cdot53g/\rho l)(v - v')$, where ρ = density and l = length of a cylinder of the same weight and density as the projectile. From this the following formula is deduced for the space traversed by the projectile in a given time: $S = v't + (u_0/a)(1 - \epsilon^{-at})$. Three examples of curves for 12-in., 6-in., and 0·303-in. projectiles are given, and the results agree so closely with actual practice as to be within the error of observation. A. W.

1286. *Motion of a Metal Wire through Ice.* **J. H. Meerburg.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 638–647, Feb. 6, 1907. Proc., 9. pp. 718–726, April 25, 1907.)—This is an account of experiments made to test Ornstein's theory [see Abstract No. 689 (1906)], according to which the velocity of descent v of a wire, loaded with a weight P and with its halves at angle 2α to each other, though an ice-block of breadth d is given by $vd \sin \alpha / 2\alpha P = C$, where C is a constant dependent on the diameter and material of the wire. The ratio of the value of C experimentally found to that calculated is only about 0·4 for steel wire and 0·7 for German silver wire, and varies from 0·21 to 0·18 for silver wire as its diam. alters from 0·5 to 0·3 mm. Roughness of the wire may partially account for the discrepancy, but lateral flow of the melted ice may have still greater effect, though experiments in which the wire was pulled up through the ice led to even less values for C. The discrepancy does not seem to depend at all on the crystalline structure of ice nor upon any possible lower temperature than 0° within the ice. R. E. B.

1287. *Complete Form of Fechner's Law.* **P. G. Nutting.** (Bureau of Standards, Bull. 3. pp. 59–64, April, 1907.)—Underlying vision, audition, and other sense perceptions, is a fundamental quantitative relation between stimulus and sensation, between the objective and the subjective. From this fundamental relation, once established, may be derived another relation giving the least perceptible increment to the stimulus in terms of the whole. Fechner's law is such a relation derived from experimental data. It states that the least perceptible increment is proportional to the whole stimulus over quite a wide range of moderate intensities. That is, the ratio of least perceptible increment to total stimulus is a constant. This constant is shown by experiment to be of the order of 2 per cent. Now, just at the threshold value of a stimulus, evidently the least perceptible increment is the whole, so that the ratio in question instead of having here the value 0·02, supposed constant, has the value unity. From the data on vision by König and Brodhun and bearing on Fechner's law, the present author draws the following conclusions: (1) The least perceptible increment δS of a stimulus S is not strictly proportional to that stimulus, but a function of the form—

$$\delta S / S = a + b e^{-T},$$

in which a and b are constants and T is a function of S. (2) A special form of the above function closely representing visual sensation is—

$$\delta L / L = P_m + (1 - P_m)(L_0 / L)^c,$$

where P_m is about 0·016 and c varies between 1/4 and 1/2. (3) Sensibility σ, as a function of stimulus S, has been derived in the form—

$$1/\sigma = S[S_m + (1 - S_m)(S_0/S)^c].$$

(4) Taking sensibility, by analogy with physical instruments, as the derivative of sensation (scale reading) with respect to stimulus, the integration of the above expression for sensibility gives for sensation in terms of stimulus the relation $B = B_0 \log [1 + S_m (S^c S_0^{-c} - 1)]$. E. H. B.

1288. *Ocean Waves.* **H. Nagaoka.** (Physico-Mathematical Soc., Tokyo, Proc. 4. 5. pp. 113–114, June, 1907.)—In the usual calculation for the time of transit of oceanic waves, no account is taken of the curvature of the earth. No rigorous solution for the general case can be found, but one can be obtained for certain special cases. Supposing the earth is covered with water of uniform depth h, the author deduces mathematically that when the waves follow the zonal harmonic distribution the velocity of propagation is nearly $1-3/(2n+1)\rho^{\frac{1}{2}}\,.\,\sqrt{gh}$, where n is large and ρ is the mean density of the earth. Hence the usual formula applies in this case very approximately, since $3/(2n+1)\rho$ is small. For sectorial distribution of waves it is shown that the velocity of propagation is nearly equal to $\sqrt{gh}$ when the waves travel along the equator, and diminishes with the increase in latitude. For the tesseral distribution no simple formula can be obtained, but the general tendency is to diminish the velocity from the usually accepted formula. In most instances of the propagation of seismic sea-waves we meet with slower velocities than that given by the canal waves, and this may, to some extent, be accounted for by the curvature of the surface on which they are transmitted. A. W.

1289. *Structure of the Ether.* **O. W. Richardson.** (Nature, 76. p. 78, May 23, 1907.)—Attention is called to an objection to theories of the ether which identify magnetic intensity with resultant ethereal velocity. By equating the mechanical and magnetic expressions for the energy of the field and assuming that the ethereal circulation at the equator of an electron is equal to the velocity of its forward motion, Lodge arives at the relation $e=4\pi a^2\sqrt{\rho/4\pi\mu}$, where e is the charge and a the radius of an electron, ρ and μ being the density and magnetic permeability of the ether. Calculating from the known values of some of these constants, the momentum due to any given magnetic distribution may be found. The expression for the momentum per unit volume at a point r, θ, from the centre of a sphere of radius a and charge e moving with velocity u is $\rho\omega=(e^2\mu u/4\pi a^2)(\sin\theta/r^2)$, where ω is the velocity of ethereal flow at a point the co-ordinates of which are r, θ with respect to the electron and its line of motion. If this expression be integrated it results that there is an infinite quantity of momentum in the field for any finite value of u, and moreover there is an infinite moment of momentum about the line of motion. The existence of this momentum would make it impossible to set a charged sphere in motion; the same result would be arrived at by any theory which makes the velocity of the ether proportional to the magnetic force. The author does not wish to contest the contention that the density of the ether is enormous. He refers to another expression for the momentum per unit volume of the ether which is led up to by electrodynamic theory. This expression is $1/4\pi$ times the product of the electric and magnetic displacements, and it has the merit of making the momentum in the ether equal to the product of the (electric) mass and velocity of the moving charge. The considerations here brought forward appear to show that the ethereal flow, if it exists, is at right angles to, and not along, the lines of magnetic force, and that the effect sought for by Lodge is not to be expected. [See Abstracts Nos. 958, 959 (1907).] J. J. S.

1290. *Ether and Electrons.* **C. V. Burton.** (Phil. Mag. 13. pp. 693–708, June, 1907.)—The author calls "aphenomenal processes" such occurrences that an observer with his surroundings may be the seat of them without any resulting phenomena being manifested to him, that is to say, they are without influence on his senses or instruments. To such belong absolute velocity in space, and even absolute acceleration under certain conditions. Thus if an incompressible substance, solid or liquid, of uniform density, is contained in a rigid envelope, that envelope with its contents may be accelerated or retarded in any irrotational manner without an observer being able to detect the acceleration, if he is confined within the envelope. This implies that if a translational acceleration of any magnitude could by suitable means be imparted to the whole of the explorable universe, we should be entirely without means of detecting it. Since the mere motion of a system through the ether does not cause that system to be the seat of a magnetic field, or of an electrostatic field, it follows that, unless we attach a very real physical significance to absolute motion of the ether in space, neither the magnetic nor the electric vector at any point is to be identified with translational velocity of the ether at that point. Otherwise our motion through the ether, being equivalent to a contrary flow of ether with ourselves at rest, would be evidenced to us by the existence of a magnetic or electric field; and if the density of the ether is very great, the field intensity arising from a moderate velocity of flow would be correspondingly great. It is also highly probable that the resultant translational velocity of an ether-element never differs from zero. The author then recasts his "strain-figure" theory of 1891 in the light of the electron theory. Strain-figures are localisations of strain and stress ideally produced by stress exerted upon a medium and surpassing a certain critical amount. Such strain-figures are capable of slow displacement without loss of energy, but it is the state, and not the substance, that is displaced. Strain-figures may be ether "free" or "locked." The former are produced by a continuous process, the latter by cutting or slitting the medium. Locked strain-figures are not in general mobile, because the motion of a locked strain-figure involves an infinite velocity for those points of the medium which at any given instant lie in the surface of discontinuity. The ethereal circulation which is specified by Larmor ("Æther and Matter," p. 326) as equivalent to the translation of his electron through the ether does not appear to be admissible as a mode of motion unopposed by the elasticity of the medium. To a first order, the elastic properties of a medium are not modified by the presence of assemblages of locked strain-figures. No property corresponding to dielectric capacity is thereby introduced. For assemblages of electrons to be able to give rise to a dielectric capacity different from that of free ether, the constitution of the electron must be assumed to involve electric displacement so great that electric displacement and electric force are no longer linearly related. But in radiation traversing free ether we are dealing with values of electric displacement which could still be well within the limits of sensibly linear relation; while the optical phenomena exhibited by (say) ordinary transparent media would fall within the category of small oscillations about a configuration of equilibrium, or about a state of quasi-steady motion, and would accordingly be deducible from linear equations. E. E. F.

1291. *Structure of the Ether.* **C. V. Burton.** (Nature, 76. pp. 150–151, June 13, 1907.)—In identifying ether flow with magnetic induction [see preceding Abstract] much the same difficulty arises when resultant ethereal momentum is taken to correspond to the vector product of the electric and magnetic vectors, and further difficulties are encountered. For electromagnetic wave-trains then involve a longitudinal wave-motion, like sound-waves. This clearly implies compressibility of the ether as a fundamental relation of electromagnetism. The solar radiation would imply an outflow of ether in all directions, maintained through immense periods of time.

E. E. F.

1292. *Structure of the Ether.* **E. Cunningham.** (Nature, 76. p. 222, July 4, 1907.)—It is not permissible to speak of the velocity of an observer relative to the ether, as though the ether were a material medium given in advance. The ether is not a medium with an objective reality, but a mental image which is only unique under certain limitations. Two frames of reference imply two ethers; so long as we restrict ourselves to a single frame, the objection to Larmor's scheme does not arise. If stated as follows, it is free from objection: "The propagation of electromagnetic effects through space, relative to a given frame of reference, may be illustrated by the propagation of disturbances in a rotationally elastic medium, it being possible *for a given frame of reference* to construct such a medium, in which the rotational displacement at any point is proportional to the electric force at that point, and the velocity, relative to the frame, of a point of the medium is proportional to the magnetic force." A uniform drift of the ether as a whole has no effect on electromagnetic phenomena. E. E. F.

1293. *Gravitational Stability of the Earth.* **A. E. H. Love.** (Roy. Soc., Phil. Trans. Ser. A. 207. pp. 171–241, May 31, 1907. Proc., Ser. A. 79. pp. 194–199, May 14, 1907. Abstract.)—In this treatise the author begins by calling attention to the difficulty of applying to a body like the earth the ordinary methods of the theory of elasticity, in which it is assumed that the strains are very small, and may without sensible error be taken as proportional to the stresses. This is inadmissible in the case of the earth; several methods of overcoming the difficulty have been suggested. Rayleigh's method, which is here followed, is that of measuring the strains, not from the state of zero stress but from the equilibrium state. In Part I. the author supposes a sphere of radius a, and of uniform density ρ_0, in equilibrium, under its own gravitation, and the stress at distance r from centre is a hydrostatic pressure p_0. If then u, v, w be the displacements of a particle initially at (x, y, z), we have three equations of the type $\rho\,.\,\partial^2u/\partial t^2=\rho\,.\,\partial V/\partial x+\partial X_x/\partial x+\partial X_y/\partial y+\partial Z_x/\partial z$, &c., in which V is the potential, and X_x, X_y, Z_x three of the stress-components. Writing now $\Delta=\partial u/\partial x+\partial v/\partial y+\partial w/\partial z$, he deduces from these three equations, the equation $(\nabla^2+h^2)\Delta+6s^2\Delta+s^2r\,.\,d\Delta/dr=0$, in which h^2 and s^2 are certain constants. The general solution of this is $\Delta=\Sigma f_n(r)w_n$, w_n being any spherical solid harmonic of degree n, and f_n a function of r for which r_nf_n is finite when $r=0$. The solutions obtained are then adjusted to satisfy the boundary conditions, namely, that the pressure is zero on the surface $r=a$, and that if W be the additional potential due to the disturbances, $\nabla^2W+4\pi\gamma\rho=0$, γ being the gravitation constant, at all internal points, with the corresponding well-known surface condition. He then finds the conditions for instability: (1) in respect of radial displacements; (2) in respect of displacements specified by harmonics of the first degree, which shall be called displacements of the first degree; (3) in respect of displacements of the second and third degrees. The results of Part I. are best given in the author's own language: "The condition for instability is the condition that a certain equation containing $\frac{4}{3}\pi\gamma\rho_0^2/(\lambda+2\mu)$, or s^2a^2, may be satisfied by a real positive value of s^2a^2. The constant μ denotes the rigidity, and $\lambda+2\mu/3$ is the modulus of compression. When the vibrations are radial, *i.e.*, specified by harmonics of zero degree, the critical value of s^2a^2 is between 4 and 5 if $\mu/(\lambda+2\mu)$ is zero, and between 3 and 4 if $\mu/(\lambda+2\mu)=1/4$. For harmonics of the first degree, s^2a^2 lies between 7·22 and 8 when $\mu/(\lambda+2\mu)=0$, and between 6·48 and 7·22 when $\mu/(\lambda+2\mu)=1/4$. For harmonics of the second or third degrees there is no critical value of s^2a^2, or the sphere is stable for all values of $\lambda+2\mu$. The result that the critical values of s^2a^2 are lower for $\mu/(\lambda+2\mu)=1/4$ than for $\mu/(\lambda+2\mu)=0$, means that a higher value of $\lambda+2\mu$ is required to secure stability when there is considerable rigidity than when there is very little." The results further suggest that a body with spherically symmetrical distribution of density, though stable for radial displacements, might be unstable for displacements of the first degree. Such a body assumes "a hemispherical distribution of density," that is, one in which the body, though spherical, has its centre of gravity slightly removed from the centre of figure. Approximate values of $\lambda + 2\mu$ for the earth, are calculated by means of a table (p. 218). From this it appears that if the modulus of compression be as great as that of steel the earth would have complete gravitational stability, if less than that of glass, it would be unstable for radial disturbances, and would concentrate towards the centre. As regards disturbances of the first degree, the mass being at the same time condensed towards the centre, the instability would, as above stated, depend mainly on the rigidity. In Part II. the author considers how far the existing distribution of land and water on the earth's surface may be accounted for, according to Jeans' suggestion, as the result of its having been at some former period in a state of gravitational instability. The mean density of the earth is greater than that of the surface rocks, that is, there is concentration of mass towards the centre. This has probably resulted from the elasticity having been once too small for the homogeneous state to be stable. Also under certain conditions a spherically symmetrical state would be unstable. This, as above shown, results in a hemispherical distribution of density. Jeans had advanced in this relation the theory that the earth would become a "pear-shaped" body, and finds the "pear" approximately in the form of the solid earth apart from the ocean, *i.e.*, the lithosphere, the stalk end being in the southern hemisphere and the centre of gravity north of the equatorial plane. A somewhat similar explanation had been proposed by Sollas, but according to the present author Sollas' "pear" and Jeans' "pear" cannot be reconciled. There follows a mathematical discussion of the hemispherical distribution. Given a homogeneous sphere devoid of rigidity, and the self-attraction balanced by hydrostatic pressure, and given that the increment of pressure is proportional to that of density, it is shown that the hemispherical distribution might give equilibrium. The effect of it is illustrated by a figure. Next is discussed mathematically the effect of rotation on a sphere in the state of hemispherical distribution, and the result is that if the modulus of compression be so small that were the body at rest a spherical symmetrical distribution would be unstable, it would tend to assume a state not exactly hemispherical, but with excess density expressed by harmonics of the third degree. The figure of the body as determined by difference of level above or below a certain equipotential surface, would be a harmonic spheroid of the third degree, but displaced towards one side. He next discusses the effect of external forces, that is, principally of the moon's attraction, at a time when the moon was nearer to the earth than now, and its period of revolution round the earth was nearly that of the earth's rotation on its axis. Such forces are derived from a potential, the most important terms of which are of the second degree, asymmetrical about the axis of rotation. The tendency is to cause the earth to assume an ellipsoidal form. Next he discusses the problem of the shape of the lithosphere, and that of the hydrosphere, or surface of the ocean. He considers that the presence of a zonal harmonic of the third degree is indicated by the Antarctic continent, and by the fact that most of the land is north of the equator. It is endeavoured to show by means of a table, illustrated by figures, that the existing distribution of land and water corresponds fairly with what might be expected from harmonics of the third degree superposed as "a wrinkle" on a lithosphere in the form of an ellipsoid of three unequal axes, with its centre of gravity displaced from its centre of figure. The geological conclusions, drawn as probable conclusions, are that the positions of continents and oceanic regions have not varied much since the epoch of consolidation—that the "wrinkles" due to harmonics of the third degree would at first be small compared with the deviations from spherical symmetry due to those of the first and second degrees, so that these latter diminish in importance except in so far as those of the second degree depend on the speed of rotation. S. H. B.

1294. *Principle of Relativity.* **A. Einstein.** (Ann. d. Physik, 23. 1. pp. 197–198, May 28, 1907.)—In a previous work [see Abstract No. 2277 (1905)] the author develops the principle of relativity, and in the present paper suggests the possibility of a new proof of this principle founded upon the observations of J. Stark on the Doppler-effect in canal rays [see Abstract No. 57 (1907)]. According to the principle of relativity there should be an effect proportional to the square of the velocity of the ions, and the effect as found by Stark is more than ten times as great as that found from the author's formula. It is suggested that a satisfactory comparison can only be made when canal rays in a completely gas-free space can be obtained. [See also Abstracts Nos. 708 and 885 (1906).] S. G. S.

1295. *Variation of Inertia with Energy on the Principle of Relativity.* **A. Einstein.** (Ann. d. Physik, 23. 2. pp. 371–384, June 18, 1907.)—The principle of relativity in conjunction with Maxwell's equations lead to the conclusion that the inertia of a body changes in a quite determinate manner with its energy-content. If, for example, we consider a body which at the same time sends a given energy of radiation in opposite directions, and examine what happens with respect to two sets of moving co-ordinate systems, one of which is at rest relative to the body; the application of the principle of energy leads to the result that to an increment of energy ΔE of the body considered there must always correspond an increment of mass $\Delta E/V^2$, where V denotes the speed of light. According to the principle of relativity, the kinetic energy K_0 of a body of mass μ not acted on by external forces and moving at speed v, is given by—

$$K_0 = \mu V^2 \left\{ \frac{1}{\sqrt{1 - v^2/V^2}} - 1 \right\},$$

where V is the speed of light. It is then shown that, on the principle of relativity, the above expression no longer holds in the case where external forces in equilibrium act on the body. Rigid bodies and systems of particles are also dealt with, and it is shown that a system of moving particles possesses the more inertia the quicker their relative motion. [See Abstracts Nos. 188 and 1863 (1906).] E. H. B.

1296. *Growth of Fog in Unsaturated Air.* **F. W. Proctor.** (Monthly Weather Rev. 35. pp. 22–27, Jan., 1907.)—Referring to his investigations on the origin of summer fogs on the south shore of Massachusetts during the summers of 1901 and 1902, which are discussed in the Monthly Weather Review for Oct., 1903, the author considers the various theories and observations of Aitken, J. J. Thomson, C. T. R. Wilson, Barus and others, and gives a summary of recent work on this subject. He concludes that saturation of atmospheric water-vapour is a relative condition, condensation beginning upon certain nuclei as soon as there is any vapour at all in the air, and progressing gradually either with growing vapour pressure or with other favouring conditions, such as concentration of dissolved matter in the nuclei, electric charge thereon, or change of shape of the condensing surface, in addition to the suitable conditions of temperature that alone are commonly considered to be the controlling factor for any given vapour pressure. Thus water vapour is always saturated for certain nuclei that are usually found in the atmosphere. Fog, then, is normally present in the lower atmosphere, at least near the sea; often invisible, the visibility depending upon the size of the droplets (nuclei) and their number per unit volume. It usually has the aspect of a thin smoky haze. Saturation is rarely indicated by observing instruments; the vapour not being saturated with respect to the covering of the wet bulb, although supersaturated with respect to the nuclei or smaller drops of the preceding stages of fog growth. There seems to be no reason to discriminate between fog and higher clouds in respect to the general aspects of condensation, evaporation and stable existence in unsaturated air, though the distribution of various kinds of nuclei probably varies with height. There would appear to be a regular gradation in the size of water particles from the smallest invisible condensation nuclei up to the largest raindrop. J. J. S.

1297. *Rainfall at Panama.* **E. B. Garriott.** (Monthly Weather Rev. 35. pp. 75–76, Feb., 1907.)—The wet season extends from April to Nov. The torrential rains come with local thunderstorms, which start late in the afternoon in April, and last longer and become more intense as the season advances. Panama receives about 67 in. of rain annually; Colon, on the Caribbean Sea, much more—157 in.; the watershed at Gamboa, between the two places, about 100 in.; this watershed is 102 ft. above sea-level, and the ground adjoining the Canal nowhere higher than 300 ft. The chief rainfall at Colon is in April, 36·5 in. August is, on the whole, a dry month in Central America, but hardly so in the Canal zone. Daily rainfalls of 5 and 7 in. will be very troublesome for a canal provided with locks. H. B.

1298. *Meteorological Work at Camp Wellman, Danes Island, Spitzbergen.* (Monthly Weather Rev. 35. pp. 63–68, Feb., 1907.)—Reproduction of the meteorological journal, covering the period June 21 to Aug. 31, 1906, kept apparently by F. B. Hersey, who accompanied the expedition on behalf of the U.S. Weather Bureau. The party arrived by the steamer *Frithjof* on June 15 from Tromsoe, equipped with Weather Bureau instruments. The anemometer was first put on a pole 38 ft. above ground, and then on the top of the gas apparatus, being 40 ft. above ground and 54 ft. above sea-level. A 4-ft. vane was fixed on Mt. Moore, 500 ft. above sea-level. Snow fell during the first days, when it froze all day, and the thermometer never rose above 50° F. Tables of temperatures and hourly wind movements are reproduced; winds from N. and N.E. seem to have predominated, but there is no summary. F. Riesenberg was left in charge of the observations in Sept., 1906, when Hersey returned. H. B.

1299. *Temperatures in the Front, the Rear, and the Central Area of Anticyclones, at altitudes up to 12 km.* **H. H. Clayton.** (Monthly Weather Rev. 35. pp. 118–120, March, 1907.)—In 1904 to 1906, L. Rotch, S. P. Fergusson, and the author carried on observations by means of ballons-sondes at St. Louis, Mo.; occasionally heights of 17 km. were reached. As a rule the lowest temperature seems, at the earth's surface, to occur in the central and south-eastern portions of an anticyclone; but at a height of 8 km. the northern quadrant is the coldest. When the eastern quadrant is the warmest on the ground, the northern quadrant will be the warmest at 8 km. Particulars are given of four anticyclones, studied in Nov. 1904, Jan. and July 1905, and May 1906. With the exception of the July anticyclone, they all moved from N.W. to S.E. Observations were taken, as far as possible, on three consecutive days, and the table represents the temperature, at heights of 0, 1, 2 . . . 11 km., observed at St. Louis on the day of max. pressure, and the departures from these temperatures on the preceding and following days. Up to about 8 km. the temperature was lower in front and higher in the rear than in the central area; between 8 and 10 km. the central area was coldest; above 10 km. the temperature was highest in front and lowest in the rear, the distribution being the opposite to the distribution on the surface. The author suggests that the cold air of the northern portion of the anticyclone is moving (towards the S.E.) more rapidly than the anticyclone, and that this cold air sinks towards the surface, the centre of the anticyclone being about midway between the N.W. and the S.E. limits of the inclined stratum of cold air. The circulation of air around a central area is confined to the first 2 km. above the surface. Reference is made to the air movements in cyclones and anticyclones as studied at the Blue Hill Observatory. H. B.

1300. *The Treatment of Wind Observations.* **J. P. van der Stok.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 704–720, March 6, 1907. Proc., 9. pp. 684–700, April 25, 1907.)—The method proposed is based upon the general treatment of directed quantities, and on the calculus of probability. A wind observation can be represented by a point on a plane such that the distance from an assumed origin is a measure for the wind force, and the angle made by the radius vector with the North axis counted from N. to E. indicates the direction. If to each point of these observations an equal mass is attached, the centre of gravity will not, as a rule, coincide with the origin. That centre of gravity will, as to size and direction, represent the constant part of the wind, supposed to be connected with all the observations whose probability is unity, and the axes of inertia will become principal axes. The two series of observations dealt with are those from Bergen, 1885–1904, three daily observations, and the seventeen years, 1874–1903 (excluding the period 1887–1899) from Falmouth, where six observations are made daily; for the Beaufort scale the values of the Meteorological Office [see Abstract No. 1188 (1906)] are adopted. In the final frequencies of wind directions at Falmouth for the four seasons nearly 10,000 observations are utilised for each season. H. B.

1301. *Trombe of May 22, 1907, in Loiret, France.* **Maillard.** (Comptes Rendus, 144. pp. 1392–1393, June 17, 1907.)—The vortex passed La Ferté-Saint-Autin, Département de Loiret, near Orléans, from south to north, turning to the east finally, and thus describing a path resembling a note of interrogation, 2 km. in length. The water of a canal which was crossed is said to have been raised 50 m. high. Two adjoining slates of a roof were driven into the wood of houses, the one to the left, the other to the right of the path; to judge from the depth to which these slates penetrated, their velocity must at least have been 150 m./sec. Many peculiar observations show that the centre of the vortex must have been at reduced pressure. Some roofs were left intact, except that the air on rushing out of the houses had torn circular holes 1 or 2 m. in diam.; doors were burst outward, and the wall of a room pushed out, no other damage being done in the room. There are no barometric records, however. The author recalls the Cravant trombe [see Abstract No. 252 (1906)]. H. B.

1302. *Temperature Distribution in the Atmosphere in Swedish Lapland and at Trappes.* **L. Teisserenc de Bort.** (Comptes Rendus, 145. pp. 149–152, July 8, 1907.)—In March, 1907, Maurice and Nilsson sent up 24 ballons-sondes at Kiruna, within the Arctic circle, while the author directed ascents from Trappes on the same days. In Sweden eight of the balloons, which reached heights of 20,000 m., were recovered. The surface temperatures were much lower at Kiruna than at Trappes (near Paris), but these differences vanished in the higher atmosphere, as A. de Quervain had observed at Moscow in 1901. The isothermal layer was found, in Lapland, at 8,000 m. on March 7 (barometer low) and at 11,000 m. on March 26 (barometer high), and this layer may now be assumed to exist all over the globe, outside the tropics. That would indicate that the cyclonic and anticyclonic disturbances marked by vertical air currents do not penetrate higher than 8,000 or 12,000 m. Most of the recovered balloons were found east of Kiruna, which would support the view of Ferrel and of Hildebrandsson that there is a general movement of the air round the Pole. H. B.

1303. *Seiches of Lakes Yamanaka, Kawaguchi, and Hamana.* **S. Nakamura.** (Physico-Mathematical Soc., Tokyo, Proc. 4. 4. pp. 78–79, May, 1907.)—The observations were made in summer, 1902, by the Author, Honda, Yoshida, Iwamoto, and Inouye. The recording cylinder of the Richard type had 2 speeds, making a revolution in 2 or in 24 hours. The first two lakes belong to the group surrounding the volcano Fuji. The amplitudes of the seiches in Yamanaka—which is very shallow (max. depth 15 m.) and regular in shape, except that one end is narrow and curved back—are very small; there are two longitudinal seiches with one and two nodes, and a transversal seiche. A model of the lake made in cement gave fairly the same ratio of the periods of these three seiches. Lake Kawaguchi is also shallow (19 m. max. depth) and about 5 km. in length, but irregular, resembling a caterpillar with slightly curved back. The amplitudes of the four or five seiches were larger, but exact determinations difficult; a model gave three longitudinal seiches, the third being tetra-nodal (not tri-nodal). Lake Hamana has, since an earthquake of 1498, formed a bay of the Pacific. It is most irregular in shape, very shallow, and the indistinct seiches are further complicated by the tidal oscillations. H. B.

1304. *Secondary Undulations of Oceanic Tides.* **K. Honda, T. Terada, and D. Isitani.** (Physico-Mathematical Soc., Tokyo, Proc. 4. 4. pp. 79–88, May, 1907.)—The authors have continued their observations [see Abstract No. 330 (1905)], at fifty bays and coast stations. The water of a bay is capable of a stationary oscillation, the entrance forming a node for the vertical motion and a loop for the horizontal motion. The period of this oscillation is $T = 4l/\sqrt{gh}$, where l is the length and h the depth of the bay. A correction is required for irregular shapes, but the corrections for the mouth and the end sometimes cancel out; not, however, when the mouth is much contracted. In some bays seiche-like lateral oscillations are observed. The present paper mentions periods of considerable length, 295 min. at Aomori, *e.g.*

Models are made of the bays by cutting horizontal sections out of plates of zinc, superposing these plates and lining the inner space with cement; oscillations of different periods are then produced by suspending pendulum bobs in the water or with the aid of horizontal pendulums. The walls are further lined with wood shavings to prevent reflection of the waves, and aluminium dust is scattered on the surface to mark stream-lines. According to Omori, the periods of great sea-waves observed in a bay are the same as those of the usual secondary undulations in that bay; this is confirmed. The amplitudes of the waves outside the bay may be very small, and yet cause strong oscillations in the bay. The calculated values agree fairly with the British Association report on the Krakatoa eruption of 1883; the Sunda Strait seems to have been thrown into a stationary oscillation of a period of 126 min., while the transversal binodal seiche had a period of 60 min. The sea-waves accompanying cyclonic storms often produce very similar waves (with embroidery) in different stations of the coasts of Japan. The waves in bays are of the resonance type, and for this reason the Bay of Fundy seems to have its exceptionally large tidal range; the authors calculate a period of 13 or 11·6 hours for the stationary oscillations of this bay, and their calculations for the mareograms of Karang Kleta (Java), Port Adelaide, and Port Phillip (Australia) are 8·8, 10·8, 8·4 hours, the observed values being 8·0, 10·9, 8·3 hours. Examples of the calculations are not given. H. B.

1305. *Depth of the Hearth of the Calabrian Earthquake of Sept.* 8, 1905. **M. P. Rudzki.** (Acad. Sci. Cracovie, Bull. 1. pp. 40–44, Jan., 1907.)—Eight years ago, the author gave a formula for the depth of the hearth of an earthquake, based upon the length of arc between the epicentre and the geometrical spot where the mean apparent superficial velocity of propagation of the phases attains a minimum. The formula presumed a knowledge of the velocity of the waves in the interior of the earth. The author now amplifies his deductions by assuming that the phases all move in rectilinear (not convex) rays, and he thus obtains the formula: $\sin \epsilon = \frac{\gamma^3}{12} - \frac{\gamma^4}{480} + \dots$. If E is the epicentre, H the hearth lying on the earth-radius CE, F the spot of velocity minimum, then angle $ECF = \gamma$, and angle $EFH = \epsilon$. Taking now G. B. Rizzo's discussion of the Calabrian earthquake as observed at 79 stations all over the globe [Accad. Sci. Torino, Mem., 57. pp. 1–42, and Abstract No. 1826 (1906)], and assuming that the EF of the velocity minima of the three phases were all about 1,500 km. (first phase probably not less than 1,300 km., third or main phase not more than 1,750 km.), the author arrives at the value 6·95 km. for the depth of the Calabrian earthquake. If 1,300 or 1,750 were substituted for 1,500 km., the depth would respectively be 4·53 or 11·01 km. H. B.

1306. *Secular Acceleration of Earth's Orbital Motion.* **P. H. Cowell.** (Roy. Astronom. Soc., Monthly Notices, 66. pp. 352–355, April, 1906.)—In the examination of the records of ancient eclipses it was found that many apparent disagreements between computed and observed values could be reconciled by introducing a solar term, and it was concluded that the procedure of assigning an arbitrary secular acceleration to the moon and none to the sun, based on the supposed action of the tides, is wrong. Following the hypothesis now formulated, the rate at which the day is increasing is six parts in 10^8, or 0·005s. per century. This amount is about ten times as large as that of previous estimations. C. P. B.

1307. *Planetary Inversion.* **F. J. M. Stratton.** (Roy. Astronom. Soc., Monthly Notices, 66. pp. 374–402, April, 1906.)—The paper gives a discussion of the influence of tidal friction in producing secular changes in the obliquities of the members of the Solar system. First, by an extension of the results previously obtained by G. Darwin, the author shows that for a planet revolving round the sun unattended by any satellite the stable position would be with an obliquity between 0° and 90° for all but large viscosities, and steadily decreasing in value as the viscosity increased. Any planet starting with an obliquity greater than 90° would, under the influence of solar tidal friction, tilt over until its obliquity had decreased below that value; this would hold good so long as no satellites with large tidal influence compared with the sun were evolved. It was next proved that if a satellite of the type found in the solar system were present, tidal friction would have no sensible effect on the position of its orbit. The additional terms due to a second satellite were then obtained in the expression for the secular changes in the planet's obliquity. The direct terms arising from the action of a satellite on its own tides tend to drive the planet's axis of rotation into the ecliptic. The cross terms arising from the action of the satellites on each other's tides and on the solar tides tend to drive the axis of rotation out of the ecliptic into a position making an angle of 90° with it. Applying these principles to the members of the present solar system, the probable evolution of their satellites is described in detail. C. P. B.

1308. *High Level Chromosphere Lines and Sun-spot Spectra.* **A. Fowler.** (Roy. Astronom. Soc., Monthly Notices, 66. pp. 361–367, April, 1906.)—Observations of the chromospheric lines with an Evershed spectroscope were made on several occasions when large sun-spots were near the limb, and comparisons made of the behaviour of the lines under the different conditions. It was possible in most cases to divide the chromospheric lines into two classes, showing long or short lines, the former indicating vapours at a high level above the photosphere. The most definite conclusion reached was that the enhanced lines of Fe, Cr, and Ti appear as high-level or long chromospheric lines, and that the corresponding Fraunhofer lines are generally enfeebled in the spectra of sun-spots. C. P. B.

1309. *Terrestrial Influence on Sun-spots during* 1889–1901. **A. S. D. Maunder.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 451–476, May, 1907.)—An extensive investigation of the tables in the Greenwich sun-spot ledgers shows that, during the period under examination, 1889–1901, there was a well-marked and steady preponderance of the eastern half of the sun's disc over the western half, both as regards the areas of the spots and the numbers of the separate groups. This excess in area of the eastern hemisphere over the western amounts to 17 per cent. for spots observed consecutively for 13 or 14 days; to more than 19 per cent. for recurrent spots during the time of their greatest stability; and to 8 per cent. for the totality of areas of spots of all sizes and durations. It was also found that the eastern prominences showed the same preponderance during the period. C. P. B.

1310. *Variations of Solar Radiation.* **H. Deslandres.** (Comptes Rendus, 144. pp. 941–947, May 6, 1907.)—After a short discussion of the previous work by Langley, Ångström, Crova, Abbot, and others on the measurement of the solar constant, a modified form of registration apparatus is proposed, with which the solar radiation is determined systematically day by day. A pinhole about 0·5 mm. diam. is employed for producing the image of the sun on a metal plate fixed about 8 m. distant. In this metal plate there are two openings. One in the form of an annulus whose outside diam. is equal to that of the sun's image, with a width of about $\frac{1}{10}$th the radius. The other is circular, with an area equal to that of the annulus. Both openings are adjusted to be concentric with the solar image on the metal plate. A Rubens thermopile placed behind each aperture is employed to register the intensity of the radiation passed by them, the readings being afterwards calibrated by determinations of the deflections produced by a standard electric lamp placed at a given distance from the pinhole. If a quartz spectrograph is employed in conjunction with the bolometer, the variations of solar radiation with respect to any particular wave-length can be determined. C. P. B.

1311. *Effective Temperature of the Sun.* **G. Millochau.** (Soc. Franç. Phys., Bull. No. 1. pp. 47–60, 1907. Journ. de Physique, 6. pp. 389–402, May, 1907.)—Review of work with the Féry pyrheliometric telescope for the determination of the solar constant. Observations were made at several stations at varying altitudes from 150 to 4,810 m. The effective temperature of the centre of the solar disc is given as 5,663° C. abs. Allowing about 37 per cent. for the absorption produced by the solar atmosphere, the temperature of the nucleus is probably about 6,132° C. (abs.). C. P. B.

1312. *Brightness of Inner Edges of Sun-spot Penumbræ.* II. **S. Chevalier.** (Astrophys. Journ. 25. pp. 273–276, May, 1907.)—It has previously been noted [Abstract No. 20 (1907)] that in photographs made at the Zo-Sè Observatory, China, the inner edge of the penumbra of sun-spots was very generally brightened. From improved photographs the author is now of opinion that this brighter ring which skirts the umbra is not really the actual edge of the umbra. Within the brighter ring there is a fainter one, probably consisting of the sharp ends of the filaments which run still farther inside the nucleus, and which must be considered as belonging to the penumbra. Specimen photographs showing enlargements of small scale pictures, and direct large scale pictures, are given, showing the superiority of the latter for delineation of minute details. C. P. B.

1313. *Observations made on the Summit of Mont Blanc.* **A. Hansky** and **M. Štefánik.** (Comptes Rendus, 144. pp. 1252–1255, June 10, 1907.)—The observations described were of solar and planetary surface details, and were made in the period Aug. 31 to Sept. 5, 1906. The atmospheric conditions found at the summit were of such surpassing excellence that the authors conclude the site to be one of the most favourable which could be found for the study of planetary surfaces. The transparency of the air was so great that mountains to the east were visible at a distance of 200 km. (124·3 miles). The rising sun appeared of a yellow tint, and on Sept. 24 the green flash was seen, which betokens absence of humidity. To the west a light smoke cloud hung over the horizon. Venus was observed on four days, during the midday or afternoon hours, and twenty-four drawings were secured, those made independently by the two observers showing great general resemblance, though differing in many details. The observations, it is stated, seem to indicate a rotation of the planet slightly more rapid than that of the earth. Not only does the aspect of the surface change from hour to hour while under observation, but details, such as bright polar spots and small dark patches, seen at a certain hour on one day are reminiscent of those seen at nearly the same hour on the day before, as if the same portion of the planet had returned to view. Thus the aspect of Venus at 12h. 55m. on Sept. 3, corresponds to that at 12h. 15m. on Sept. 4, and the aspect at 1h. 10m. on Sept. 3, to that at 12·35 on Sept. 4. Mercury, which was easily visible to the naked eye, was observed on Sept. 5. Three dark spots could be distinguished with the telescope, one at the middle of the terminator, and two others, smaller, towards the east limb of the planet. Jupiter was observed on Sept. 3, 4, and 5, in the morning, and several drawings were made, but more details were seen than could be represented. The north equatorial belt, which had been almost invisible four months before, had become as large and dark as the southern. The dark equatorial bands were double. A. E.

1314. *Origin of Irregularity of the Lunar Surface.* **Lœwy** and **Puiseux.** (Comptes Rendus, 144. pp. 1193–1196, June 3, 1907.)—In the study of the ninth volume of the photographic Lunar Atlas, prepared from photographs taken with the Coudé equatorial, the authors find evidence of several details in which the relief of the lunar surface is distinguished from that of the earth. Chief among these are the greater relative importance of differences of level, the circular form of the basins persisting at all latitudes with very varied dimensions. The possible explanation of these by the falling of a series of small satellite like bodies while the moon was semi-solid is considered. C. P. B.

1315. *Origin of Lunar Seas.* **Lœwy** and **Puiseux.** (Comptes Rendus, 144. pp. 1309–1314, June 17, 1907.)—Examination of velocities and other conditions necessary to produce indentations on lunar surface on the theory that they have been made by impact of bodies from outside. Result of the discussion renders the outside impact theory very doubtful. C. P. B.

1316. *South Polar Cap of Mars.* **P. Lowell.** (Nature, 76. p. 161, June 13, 1907. From Bull. No. 26 of the Lowell Observatory.)—Observations of the south polar cap during the favourable opposition of 1905. The paper gives the latitudes of the edge of the cap in successive longitudes as seen during the period May 10 to Aug. 14. They indicate that during the beginning of the opposition cloud or mist enveloped the polar cap, as the edge was not definitely recognised until May 15. [See Abstract No. 803 (1907).] C. P. B.

1317. *Observations of Jupiter's Sixth and Seventh Satellites.* **W. H. M. Christie.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 479–482, May, 1907.)—The paper exhibits in tabular form the positions of the satellites as deduced from measures of photographs taken at Greenwich with the 30-in. reflector. Satellite VI. was under observation from Aug. 28, 1906, to April 6, 1907, and 55 photographs were obtained on 28 nights. During this period of 222 days the satellite performed nearly a complete revolution around the primary, the position angle being 208° on Aug. 28, and 240° on April 6. Its apparent distance from the primary was greatest, 3,411″, on Nov. 22, and least, 1,525″, on Jan. 17. Of Satellite VII. 12 photographs were taken on 7 nights during a period of 87 days, from Nov. 17, 1906, to Feb. 11, 1907. The position angle diminished in this interval from 85° to 301° (or −59°), and the apparent distance varied from 1,258″ on Dec. 12, when it was least, to 3,916″ on Feb. 11 when it was greatest. A number of photographs of Jupiter itself were also taken, by aid of the occulting shutter, in order to determine the error of the planet's tabular place as given in the Nautical Almanac. A. E.

1318. *Spectrum of Saturn.* **V. M. Slipher.** (Nature, 76. p. 162, June 13, 1907. From Bull. No. 27 of the Lowell Observatory. Astrophys. Journ. 26. pp. 59–62, July, 1907.)—From a photographic study of the spectrum of Saturn made during the autumn of 1905, special absorption bands were found at λλ6193, 5430, 6145, 6450, 5770, these being in order of decreasing intensity. These are not detectable in the spectra of the rings, indicating that if the rings do possess any atmosphere it must be much rarer than that of the ball. C. P. B.

1319. *Spectrum of ε Capricorni.* **V. M. Slipher.** (Astrophys. Journ. 25. p. 285, May, 1907.)—Spectrograms of this star obtained at the Flagstaff Observatory, Arizona, during the autumn of 1906 with the single-prism spectrograph, indicate that the spectrum contains bright lines. At Harvard the spectrum was recorded as peculiar, but the bright lines were not mentioned. On the later plates the dark hydrogen and metallic lines were displaced towards the red by an amount corresponding to a velocity of 45 km. on Oct. 8, which had decreased to 35 km. by Oct. 27. Helium absorption lines are also present, but they are broad and indefinite—measures on some of the most distinct indicate a small displacement towards the violet. It seems probable that the dark hydrogen and metallic lines belong to one component, and the diffuse helium and bright hydrogen lines to the other component, and that the weak bright lines are blotted out by the intense dark ones, except when the relative velocity of the two stars is sufficient to separate the two lines. C. P. B.

1320. *Elements of Variable RV Andromedæ.* **A. S. Williams.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 491–493, May, 1907.)—More accurate elements have been determined by the discussion of a greater number of observations, the epochs of maximum being closely given by M = 1904, April 26 (J.D. 2416597) + 170·2d. E., the interval M–*m* being 82 days. There seems to be evidence, however, that the interval from minimum to maximum is not constant, which would, of course, mean that the form of the light-curve is in a state of change. The curve is very acute at the time of maximum, and the decline is very quick. After the minimum there is sometimes at first only a slight increase in brightness, followed by a long standstill, or even by a secondary minimum, with an intervening secondary maximum, as observed by Nijland in 1906. C. P. B.

1321. *Stellar Parallaxes at Yale Observatory.* **S. I. Bailey.** (Science, 25. pp. 749–751, May 10, 1907. From Trans. of the Astronom. Observatory of Yale Univ.)—W. L. Elkin undertook in 1884 to determine, by means of the heliometer, the parallaxes of the ten stars of the first magnitude in the northern sky, and carried out the work in the interval up to 1894. The work was extended to include all rapidly-moving stars not previously attempted. Systematic personal error was avoided by the use of a reversing prism eyepiece. For each star in most cases twelve complete observations were made, In all 178 stars have been studied, and the results are collected into five groups, arranged according to various arguments, showing the relation between parallax and proper motion, stellar magnitude, size of parallax, order of right ascension, and spectral type. C. P. B.

1322. *Nova T Coronæ* (1866). **E. E. Barnard.** (Astrophys. Journ. 25. pp. 279–282, May, 1907.)—This body is probably, with the possible exception of Nova Persei, the only new star which was known previously to its outburst, and is the brightest of these objects now visible. Observations of the focus on the star show no appreciable differences from the focus on stars near to it, but this may be due to the fact of the star being still comparatively bright. The star is almost colourless, with a possible tinge of yellow at times, but it is certainly not white. Its present magnitude is 9·8, being about the same brilliancy as it was before its outburst in 1866, and as far as can be detected its position has not changed in the interval. C. P. B.

1323. *Photographic Detection of Variability of Asteroids.* **J. H. Metcalf.** (Astrophys. Journ. 25. pp. 264–266, May, 1907.)—By the method described in a previous paper [Abstract No. 1359 (1906)] the photographic plate is made to follow the mean motion of asteroids in opposition at that season of the year in which the plate is taken. To eliminate error two exposures are always taken, separated by a small amount in right ascension, and if these times are equal, the two images ought to be of the same size, shape and density. Practically this degree of precision is difficult to attain, but by examining the variations of the star-trails on the same plate it is possible to eliminate any errors due to non-uniformity of driving or variations of atmospheric transparency. If under such circumstances the two images of the asteroid show variations of density or size, it may safely be presumed that there has been a change of its luminosity during the exposure interval. An example showing this is reproduced in the paper, illustrating probable variability in the asteroid 1906 WE, discovered by the author at Taunton on Oct. 26, 1906. C. P. B.

1324. *Discovery of Second Asteroid very near Jupiter.* **E. Strömgren.** (Astronom. Nachr., No. 4177. p. 13, May 18, 1907. Nature, 76. p. 136, June 6, 1907. Abstract.)—An investigation of the orbit of the interesting minor planet 1907 XM, discovered by Kopff at Heidelberg on Feb. 19, has been carried out by the present author, leading to the fact that the body is similar to the remarkable asteroid T.G. (1906) in that its abnormally great aphelion distance lies in the immediate neighbourhood of Jupiter's orbit. From the elements given it appears that the length of the semi-major axis of the orbit is 5·28 astronomical units, that of Jupiter being 5·20. C. P. B.

1325. *Third Asteroid near Jupiter.* **V. Heinrich.** (Astronom. Nachr., No. 4181. p. 88, June 1, 1907. Nature, 76. p. 161, June 13, 1907. Abstract.)—From a determination of the orbital elements of the asteroid 1906 VY, the author finds that it is another companion to 1906 T.G. The length of semi-major axis of orbit is about 5·19 astronomical units. C. P. B.

REFERENCES.

1326. *Viscosity of Liquids.* **R. Ladenburg.** (Ann. d. Physik, 23. 3. pp. 447–458, July 5, 1907.)—A theoretical addendum to the work dealt with in Abstract No. 787 (1907).

1327. *Waves produced by a given Distribution of Pressure, which Travels over the Surface of Water.* **V. W. Ekman.** (Ark. för Mat. Astron. och Fysik, Stockholm, 8, 11. pp. 1–18, 1907.)—A further problem [see Abstract No. 608 (1907)].

1328. *Lœwy's Method of determining Circle Errors.* **Gonnessiat** and **Fayet.** (Comptes Rendus, 145. pp. 157–165, July 16, 1907.)—The authors have applied Lœwy's method [Abstract No. 2006 (1906)], and find it practical, rapid, and accurate. L. H. W.

1329. *Snow Rollers at Canton, N.Y.* **M. L. Fuller.** (Monthly Weather Rev. 35. pp. 70–71, Feb., 1907.)—Snow rollers were formed in the afternoon of Feb. 19, when a warm wind blowing from S.W. at 30 or 40 miles an hour displaced the much lighter winds from N.E. An observation made by I. A. Jillson in 1895 is mentioned; she saw that the wind would raise a triangular "card" of snow several times before it could turn it over and start a roller. [Compare Abstract No. 17 (1907).] H. B.

1330. *Atmospheric Currents in Celestial Bodies.* **J. C. Solá.** (Astronom. Nachr., No. 4185. p. 145, June 21, 1907. Nature, 76. p. 229, July 4, 1907. Abstract.)—An attempt to discuss the causes determining the convection phenomena in the atmospheres of such celestial bodies as Jupiter and Saturn, ascribing them in the main to the tide-raising effects of very small satellites. C. P. B.

1331. *Computation of Secular Perturbations.* **R. T. A. Innes.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 427–443; Appendix by **F. Robbins,** pp. 444–447, May, 1907.)—Analytical discussion of the two alternative methods of computing planetary secular perturbations, with a set of tables showing for each degree of the quadrant the logarithmic values of the functions involved. C. P. B.

1332. *Total Solar Eclipse, Aug.* 30, 1905. **Schwarzschild** and **Runge.** (Astronom. Mitteil. d. kōnigl. Sternwarte zu Göttingen, Part 30. Nature, 76. p. 89, May 23, 1907. Abstract.)—Observations were made during the eclipse with a prismatic camera and a coronograph at Guelma, in Algeria. The results deal with the brightness and spectral photometry of the corona, and the spectrum photographs included the region λ4590 to λ3330. C. P. B.

1333. *Total Solar Eclipse, Aug.* 30, 1905. **T. C. Porter** and **W. P. Colfox.** (Roy. Soc., Proc. Ser. A. 79. pp. 296–310, June 8, 1907.)—The observers occupied a station near Philippeville, on the Algerian coast, and made records of the coronal structure, polarisation and spectrum, shadow bands and meteorological phenomena. C. P. B.

1334. *Double Lines in Flash Spectrum.* **J. Hartmann.** (Phys. Zeitschr. 8. pp. 379–383, June 1, 1907. Astrophys. Observatorium, Potsdam, April 17, 1907.)—Discussion as to the apparent doubling of the spectrum lines found on prismatic camera spectrograms of the chromospheric spectrum during total solar eclipses. The phenomena has been ascribed by Julius to anomalous dispersion, and by others to movement of the moon's limb, or slight defects in focussing, both of which may produce the effect noticed. C. P. B.

1335. *New Elements of Jupiter's Seventh Satellite.* **F. E. Ross.** (Astronom. Nachr., No. 4175. p. 359. Nature, 76. p. 89, May 23, 1907. Abstract.)—From twelve observations made during the period Jan. 3, 1905, to Sept. 25, 1906, a new set of elements have been computed for Jupiter VII. The principal perturbations have been included. The period comes out to be 260·06 days. C. P. B.

LIGHT.

1336. *New Form of Illumination Photometer.* **W. Bechstein.** (Zeitschr. Instrumentenk. 27. pp. 178–183, June, 1907. Communication from the optical works of Franz Schmidt and Haensch, Berlin.)—An illustrated description is given of a new form of illumination photometer, the essential feature of which is the use of a fixed sector of variable aperture in conjunction with a rotating optical system containing a wedge-shaped lens. The principle of this arrangement, which is due to Brodhun, has already been explained in Abstract No. 624 (1907). Another design is also described, in which the sector of variable aperture is replaced by an improved form of the tube used in Weber's photometer. A. H.

1337. *A New Determination of the Metre in Terms of the Wave-length of Light.* **R. Benoit, C. Fabry,** and **A. Perot.** (Comptes Rendus, 144. pp. 1082–1086, May 21, 1907.)—The authors have re-determined the length of the standard metre in terms of the wave-length of the red line of cadmium and find that 1 m. $= 1{,}553{,}164{\cdot}13 \times \lambda$ and $\lambda = 0{\cdot}64384702\,\mu$, the measurements being reduced to 760 mm. and 15° on the hydrogen scale. E. C. C. B.

1338. *Absorption of the Air for Light of Short Wave-lengths.* **T. Lyman.** (Nature, 76. p. 222, July 4, 1907.)—Schumann has stated that oxygen absorbs all rays shorter than about $\lambda = 1800$ t.m.; the author, however, finds that this absorption is limited in extent. There is, in fact, an absorption band with very definite limits. With a column of oxygen 9 mm. long at a pressure of 380 mm., this band extends from $\lambda = 1750$ to $\lambda = 1275$. Although the investigation below $\lambda = 1230$ is hindered by the opacity of the flourite windows of the absorption chamber, it appears possible that light of even the shortest wave-lengths may be able to penetrate air-paths of more than 1 cm. The application of this to the ether vibrations of very high frequency is important. E. C. C. B.

1339. *Absorption by Ozone of the Radiations from Sources at Different Temperatures.* **E. v. Bahr.** (Ark. för Mat. Astron. och Fysik, Stockholm, 3. 15. pp. 1–10, 1907. Communication from Upsala Univ.)—Ozone is known to exhibit two absorption bands, one at $\lambda = 4{\cdot}8\,\mu$ and the other between $\lambda = 9\,\mu$ and $\lambda = 10\,\mu$. In this paper are given measurements of the absorptive power of ozone for rays from sources at different temperatures. The sources were a black body at −70°, 216°, and 352°, and also from a Nernst lamp, the measurements being made with a bolometer. Pure oxygen was enclosed in two parallel glass tubes with rock-salt ends and connected through a sulphuric acid manometer. The oxygen in one tube was ozonised by the passage of a silent discharge, the amount of ozone formed being calculated from the fall of pressure. Full results are given in the paper. E. C. C. B.

1340. *Wave-lengths of Emission and Absorption Bands in the Infra-red Spectrum from Former Observations.* **W. H. Julius.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 811–817, April 11, 1907. Proc., 9. pp. 706–713, April 25, 1907.)—Between 1887 and 1891 the author investigated a number of infra-red spectra by means of a rock-salt prism. Though the positions of the bands were ascertained with considerable accuracy, the exact wave-lengths corresponding could not be determined, the dispersion of rock-salt being at that time insufficiently known. The published results were therefore in the form of direct observations, namely galvanometer deflections, and angles of minimum deviation. It is true that rough estimates of the wave-lengths, obtained by extrapolation, were added, but with the express statement that they were uncertain. Since then Langley and Rubens have published sets of optical constants for rock-salt, and the resulting dispersion curves have been compared by Moll in a recent paper. The two curves diverge sensibly in the infra-red region, though coincident in the visible spectrum. The author, in the present revised version of his former results, tabulates the refractive indices for the maxima of emission and absorption (temp. 20°), and the wave-lengths according to the dispersion curves both of Rubens and Langley. Small corrections have been applied for an instrumental error which rendered the angles of minimum deviation too small in the earlier results. A. E.

1341. *Thermo-chemistry of Flame Spectra at High Temperatures.* **W. N. Hartley.** (Roy. Soc., Proc. Ser. A. 79. pp. 242–261, June 8, 1907. Chem. News, 95. pp. 265–268, June 7; 277–279, June 14, and pp. 289–290, June 21, 1907.)—In this paper the high-temperature flame reactions are dealt with and principally those of the alkali and alkaline earth metals. In the high-temperature flame spectra of compounds of these elements bands are visible along with the usual lines. These bands the author proves to be unquestionably due to the elements and not, as has been suggested by previous experimenters, to oxides or other compounds. The author arrives at his conclusions from observations upon the spectra as obtained in the oxy-hydrogen, the carbonic oxide and the cyanogen flames, and also from a consideration of the thermo-chemistry of the compounds concerned.

E. C. C. B.

1342. *Flame Spectra of Metals.* **G. A. Hemsalech** and **C. de Watteville.** (Comptes Rendus, 144. pp. 1338–1340, June 17, 1907.)—Describes a method for producing flame spectra from metals of which only a little is available. An electric spark from a large condenser is passed between knobs of the material under test and contained in a small glass bulb. Through this bulb the air passes to the gas-burner, whose flame spectrum is then observed. [See Abstract No. 343 (1905).] E. H. B.

1343. *Temperature Emission and Applicability of Kirchhoff's Law.* **C. Fredenhagen.** (Phys. Zeitschr. 8. pp. 407–415, June 15, 1907. Theoret.-phys. Inst., Leipzig, May 3, 1907.)—In reply to Reinganum's criticism [see Abstract No. 851 (1907)], the writer maintains his position and gives fuller experimental details regarding his previous work [Abstract No. 689 (1907)]. H. Konen's investigations, confirmed by those of the writer, have shown that the selective absorption of iodine vapour begins to decrease quickly in those temperature regions in which the dissociation of the iodine molecule becomes more prominent, and that at very high temperatures selective absorption has practically completely disappeared. Chemical reaction is therefore considered to be the cause of selective absorption or emission by iodine vapour. The applicability of Kirchhoff's law to Bunsen flame spectra is then considered, these being viewed not as temperature spectra but reaction spectra; and the fact that flames absorb selectively the lines which they emit selectively is explained, not by the Kirchhoff law, but by means of the general principles of resonance. G. E. A.

1344. *The Lines of Greatest Sensitiveness in the Spectra of Metals.* **A. de Gramont.** (Comptes Rendus, 144. pp. 1101-1104, May 21, 1907.)—The lines of greatest sensitiveness in a spectrum the author defines as being those which appear most easily when the element in question is present in very minute quantities. These lines are not necessarily the strongest in the spectrum of the pure element, but are those which resist the intercalation of strong self-induction whatever may be the exciting cause: arc, spark, or flame. The author has investigated the elements Li, Na, Cu, Ag, Au, Zn, Mg, Ca, Sr, Al, Th, Ge, Sn, Pb, Bi, Cr, and Fe both in the visible and ultra-violet regions and gives the lines of greatest sensibility; these measurements, he says, will be of great value in spectral analysis. E. C. C. B.

1345. *Measurements of the Wave-lengths in the Spectrum of Iron to Establish a Spectroscopic Standard.* **H. Buisson** and **C. Fabry.** (Comptes Rendus, 144. pp. 1155-1157, May 27, 1907.)—This paper marks the completion of the measurements of lines in the iron spectrum, undertaken with a view of setting up a new standard for spectroscopic measurements based on Michelson's value for the cadmium red line. The list contains 115 lines between the limits $\lambda 6495$ and $\lambda = 2784$. [See Abstract No. 1564 (1906).] E. C. C. B.

1346. *Displacements of Absorption Bands of Crystals with Temperature Changes.* **J. Becquerel.** (Comptes Rendus, 144. pp. 1336-1338, June 17, 1907.)—The author from previous experiments (particularly with the band 522·1 μμ of *xenotime*) had drawn the conclusion that no displacement of bands occurred with change of temperature. He now finds that the absence of such displacement is exceptional. The bands of the crystals of *lysonite* (fluoride of Ce, La, Di), of *parisite* (carbonate of Ce, La, Di, Ca, with fluorine), of *monazite* (phosphate of Ce, La, Di, Th) are all more or less displaced towards shorter wave-lengths when the temperature is lowered. Between 25° and −186° (liquid air) the displacements are in general of the order of 0·1 to 0·2 μμ. The greatest changes were observed for the bands 517·6 μμ of *tysonite* and 518·9 μμ of *parisite*, viz., of the order 0·37 μμ. In *xenolime* a large number of the bands were displaced in the opposite sense. [See also Abstracts Nos. 625, 845, and 1153 (1907).] E. H. B.

1347. *Ultra-violet Fluorescence of Benzene.* **J. Stark.** (Phys. Zeitschr. 8. pp. 81-85, Feb. 1, 1907. Nature, 75. p. 295, Jan. 24, 1907.)—The author has concluded that a banded spectrum running towards the red produces fluorescence. Hartley and others have described in the case of benzene a banded absorption spectrum in the ultra-violet, and this was taken to indicate an ultra-violet fluorescence. This was detected by illuminating a 0·25 per cent. solution of benzene in alcohol with the ultra-violet light from a mercury lamp, and examining the fluorescent light with a quartz spectrograph. Four strong continuous bands were detected in the ultra-violet, the heads of which had the wave-lengths 272, 280, 283, and 292 μμ. T. M. L.

1348. *Doppler-effect in the Spectrum of Canal Rays in Hydrogen.* **F. Paschen.** (Ann. d. Physik, 23. 2. pp. 247-260, June 13, 1907.)—Experiments in which measurements are made of the Doppler-effect in canal rays, discovered by J. Stark [see Abstract No. 1055 (1906)], are described. The preparation of the gas and production of the spectrum come first, the lines being photographed and the distribution of intensity being measured by photometrical observations of the blackening of the film. Since the different lines of the series have different actinic effect upon the plates of various makes, the exposures were so adjusted that approximately the same blackening is produced in each case. Curves are plotted with $\Delta\lambda/\lambda$ as abscissæ and intensity of blackening as ordinates in each case. Measured in this way the greatest intensity is found at the same distance from the "rest" position for all the lines of the series—a result which is not in accordance with Stark's observations. For values of the kathode p.d. below 8,000 volts there are two Doppler bands: No. 1 which is present alone at the lower voltages and which is the more displaced, and diminishing in intensity as the voltage rises to between 2,000 and 8,000 volts, while the band No. 2, which is the less displaced, increases in intensity with rise of voltage. Assuming that the energy (Ve) acquired in the dark space is entirely converted into kinetic energy ($\frac{1}{2}mv^2$) a value for e/m is calculated, and it is found that this decreases as the p.d. and velocity increase, but for band No. 1 it lies between the limits 8,000 and 7,000, while for No. 2 its value for maximum blackening lies between 1,800 and 800, the lower limit for very high voltages not being definite. The author explains these effects on the assumption that the energy acquired by the ions in their travel through the dark space is not all converted into kinetic energy, but that there is a frictional effect which would, of course, increase with the velocity. For the velocities in the two bands to be of the same order it is necessary to consider that there are more neutral molecules attached to the ion in the case of No. 2 than No. 1. This also explains the difference in the order of the quantity e/m in the two cases. Assuming the real value 8,218 for e/m for No. 2 and 9,654 for No. 1, the ratio of observed velocity to velocity with no friction is calculated for the various p.d.'s, and this is found to decrease as the p.d. rises, but more rapidly in the case of No. 2 than No. 1. The author also disagrees with Stark's conclusion that the emission of light begins at a certain limiting value of the velocity, and considers that light is only emitted when the acceleration of the body consisting of the charged ion and the neutral body is changing due to change in electric field, the effect being similar to that produced by a change in the force acting upon one of a pair of bodies elastically coupled together. [See also Abstract No. 58 (1907).] S. G. S.

1349. *Origin of Röntgen Rays.* **C. H. Wind.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 855–859, April 11, 1907. Proc., 9. pp. 714–718, April 25, 1907.)—Wien and Carter have measured the fraction of the energy of the kathode rays that is transformed into Röntgen rays, and so from the theory of Abraham have deduced the thickness of the pulses constituting the latter. [Abstract No. 291 (1907).] These results do not agree well with those deduced by Haga and Wind from diffraction experiments. Various suggestions have been made to account for this [for which see the present paper]. The view is now advanced that not simply the kathode-ray electrons, but also the atoms of the antikathode are the principal centres of emission of the Röntgen rays. When an electron passes through an atom, the electromagnetic field of the latter is altered and a pulse sent out. About the character of these pulses we can say little without making definite assumptions as to the nature of the atom, but there is one point in which all the pulses will be to a certain degree similar, viz., their duration. The thickness of these pulses will be of the order ca/v, where $c =$ velocity of light, $v =$ that of the electron, and $a =$ diam. of the atom. This gives a magnitude slightly exceeding the pulse thickness obtained from diffraction, and hence these disturbances might be Röntgen rays. It is possible that experiments on these lines would throw light upon the structure of atoms. R. S. W.

1350. *β-rays from Potassium.* **N. Campbell.** (Cambridge Phil. Soc., Proc. 14. pp. 211-216, June 18, 1907.)—The object of the experiments is to determine whether the rays carry an electric charge. Their great penetration indicates that they are not α-rays, but it does not decide whether they are β- or γ-rays. It is proved incidentally that their photographic action is beyond doubt [see also Abstract No. 1352 (1907)], but it is too feeble for these experiments. Finally it is sought to establish the deflection of the rays by an electrostatic field. They pass from the potassium salt between the plates of a grid formed of zinc sheets, then through an aluminium window into a vessel where the ionisation they produce is measured. A p.d. of 8,000 volts is maintained between the alternate plates of the grid and the ionisation is tested with the field on and off, and also in blank experiments when no salt is below the grid. The field causes a decrease of the potassium rays entering the testing vessel of 14 per cent. It is therefore concluded that the potassium rays are β-rays of an average velocity less than the β-rays of uranium. R. S. W.

1351. *New Experimental Arrangement for Measurements of Becquerel Rays.* **A. H. Bucherer.** (Phys. Zeitschr. 8. p. 430, July 1, 1907. Physikal. Inst., Bonn, May 30, 1907.)—A particle [illegible] radium *fluoride* serves as the source of the rays, and is found to be more active than the bromide. A particular combination of a cylindrical condenser and a solenoid is then described by which the rays are simultaneously subjected to electric and magnetic fields. These are so arranged as to give a photographic curve expressing the specific charge as a function of the velocity. [See Abstract No. 1070 (1907).]

E. H. B.

1352. *Radio-activity of the Alkali Metals.* **N. R. Campbell** and **A. Wood.** (Cambridge Phil. Soc., Proc. 14. pp. 15-21, March 6, 1907.)—Potassium salts exhibit a radio-activity greater than that of any other substance tried hitherto which does not contain one of the so-called radioactive elements. The radio-activity is an intrinsic property of the element, and is not due to any impurity contained in the salts. A comparison of different salts showed that the activity is an additive property. The activity of potassium as measured by the ionising power of its salts is one-thousandth of that of uranium as measured by the ionisation due to the β-rays from that substance. The activity of rubidium salts is much less; that of cæsium, sodium, and lithium is too small to be measured. The rays from potassium salts are heterogeneous and vary in penetrating power from that of the β-rays of uranium downwards; the penetration of the rubidium rays is much smaller. A photographic effect has been obtained from potassium salts by an exposure of 28 days. T. M. L.

1353. *Radium and Geology.* **J. Joly.** (Nature, 76. p. 8, May 2, and p. 102, May 30, 1907.)—(1) Typical rocks from the Simplon Tunnel contain quantities of radium considerably in excess of the average of igneous rocks. The Simplon rocks are altered sediments, and there appears to be sufficient radium to account for the excessive temperatures met with in boring the tunnel. It is suggested that radium accumulating in great thicknesses of sedimentary deposits may enter as a factor in mountain-building by raising the temperature at the base of the mass. (2) A sample of red clay from a depth of 2,740 fathoms in the North Atlantic contained sixteen times as much radium as the average of igneous rocks, and a specimen of globigerina ooze from a depth of 1,990 fathoms in the South Atlantic about six times this average. These results are considered to be further evidence in favour of the extra-terrestrial origin of some portion of the radium found upon the earth. **O. Fisher.** (Ibid. p. 81, May 9, 1907.)—Referring to Joly's remarks on the rocks of the Simplon Tunnel the writer mentions the following facts. From Strutt's investigations it appears that the average content of igneous rocks would be sufficient to account for the ordinary temperature gradient in the earth's crust if due to radium. Thus the gradient ought to have been higher than the average, viz., 1° F., for between 50 and 60 ft. But in fact, as beneath other mountains, it was considerably lower. It was 1° F. for 92 ft. In the St. Gothard Tunnel it was 1° F. for 102 ft., and in the Mt. Cenis 1° F. for 100 ft. The higher gradient in the Simplon was probably caused by the spring, 28° hotter than the rock, which brought up heat from a lower level. It is suggested that Joly's examination of the Simplon rocks is rather unfavourable than otherwise to the hypothesis that the heat of the earth's crust is due to radium. J. J. S.

1354. *Origin of Radium.* **E. Rutherford.** (Nature, 76. p. 126, June 6, 1907.)—It has been pointed out in a previous paper that although radium is produced in preparations of actinium there is no definite evidence that actinium itself is the true parent of radium [see Abstract No. 257 (1907)]. In the solution previously used it is found that the growth of radium is uniform over 120 days. By successive precipitation with ammonium sulphide an actinium solution has been obtained which initially is almost entirely free from radium, but which contains an excess of radio-actinium. The radium again grows at a uniform rate, but 1·5 times greater than the normal. This indicates that the radium-producing substance is present in excess of the normal amount. After suitable chemical treatment a small precipitate of actinium is obtained which is 100 times as active as the original preparation. This is dissolved in HCl, and in this solution no appreciable growth of radium has been observed over 80 days. It is therefore concluded that in commercial preparations of actinium there exists a new substance which is slowly transformed into radium. It is not possible at present to decide whether this substance is a final transformation product of actinium; it may be a product between UrX and radium, in which case the position of actinium in the radio-active series still remains unsettled. R. S. W.

1355. *Origin of Radium.* **F. Soddy.** (Nature, 76. p. 150, June 18, 1907.)—Soddy has previously found that uranium gives rise to radium, but only to 1/1000th of the amount it should do theoretically if the radium is produced directly. [See Abstracts Nos. 748 and 1585 (1905).] Boltwood, on the other hand, found no such growth [Abstract No. 2058 (1905)], and therefore concluded that Soddy's results are without significance. It is here pointed out that the uranium solutions used by these two observers were purified in different ways, and therefore it is quite possible that intermediate products were removed in one case and not in the other, thus accounting for the contradictory results obtained. This view is supported by the recent experiments of Rutherford on the production of radium by actinium. [See preceding Abstract and Abstract No. 68 (1907).] R. S. W.

1356. *Decomposition of Radium Bromide.* **A. W. Porter.** (Nature, 76. p. 151, June 13, 1907.)—On opening a tube of radium bromide a strong odour of bromine was noticed. It is calculated from the time the tube had been closed that 2×10^{-7} gm. of bromine would be present, and it is asked whether this would be detectable by its odour. **A. C. G. Egerton** (Ibid. p. 174, June 20, 1907) states that the minimum quantity of bromine that is detectable by smell is between 10^{-8} and 10^{-10} gm. per c.cm. R. S. W.

1357. *Secondary Rays caused by α-Rays.* **M. Moulin.** (Comptes Rendus, 144. pp. 1416–1417, June 24, 1907.)—The existence of secondary rays has been put in doubt by Bragg, Kučera, and Mašek. Experiments are here performed which show their presence. The radiations from polonium pass through a series of tubes and then through a metal meshwork, t', at such a p.d. as to stop the slowly-moving negative rays from the polonium. The α-rays then pass through another metal gauze, t, and fall finally on a metal plate M. If t is positive with respect to M, an electrometer joined to M receives a current $i_1 = i_0 + \alpha + \beta$, which is made up of i_0, due to the residual gas, which may be made small by working in a vacuum, and the charge carried by the α-rays, β the negative charge carried from the plate by the secondary kathode rays. If t is negative $i_2 = -i_0 + \alpha$. Experiment shows a great difference between i_1 and i_2; this dissymmetry is greatly diminished by a transverse magnetic field, which causes the kathode rays to describe cycloids and return to M. R. S. W.

1358. *Radio-activity of Vesuvian Cotunnite.* **F. Zambonini.** (Accad. Lincei, Atti, 16. pp. 975–978, June 16, 1907.)—Cotunnite, a mineral found in the products of all Vesuvian eruptions, and containing lead but no appreciable quantity of uranium, has a radio-activity equal to about 1·1 times that of pure crystallised uranium nitrate. The radio-activities have been compared by means of a Curie electroscope, and the mineral projected from the crater in 1872 is found to be as active as that from the eruption of April, 1906. A specimen of galena from the latter eruption is much more strongly radio-active than the cotunnite. W. H. Si.

REFERENCES.

1359. *Microphotography in Colour.* **C. A. François-Franck.** (Comptes Rendus, 144. pp. 1340–1342, June 17, 1907.)—Describes the results obtained in colour microphotography with ordinary and polarised light with the autochromatic plates of A. and L. Lumière. One plate only is required; no details of the method are given. E. H. B.

1360. *An Amalgam Lamp giving a Spectrum of many Lines.* **L. Arons.** (Ann. d. Physik, 23. 1. pp. 176–178, May 28, 1907.)—A lamp of the well-known type but containing an amalgam of the formula Hg_3PbBi, to which some Zn and Cd may be added. The spectrum of the light given is very rich in lines. E. C. C. B.

HEAT.

1361. *Thermal Conductivity of Indiarubber.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 14. pp. 190–193, June 18, 1907.)—This paper gives a description of a student's method for determining the thermal conductivity of indiarubber, devised by C. T. R. Wilson and the author. The method is, in principle, applicable to any substance of very low thermal conductivity, and only differs from Péclet's original method by the substitution of a tube for a plate. Steam from a small boiler A flows through a tube of indiarubber which passes through three rings of wire fixed inside a copper calorimeter B, and finally escapes into a vessel C. Two screens prevent radiation from A or C reaching B. The calorimeter contains water, which is kept stirred, and the temperature of this water is observed by a sensitive thermometer. Starting with a temperature five or six degrees below the temperature of the room, and steam flowing freely, 1-min. readings of the temperature are taken till it is as much above that of the room. From these results a curve is obtained, the tangent to which, at the point corresponding to the room temperature, gives the rate of rise of temperature due to conduction through the rubber-tubing. If l is length of tube immersed in water, a and b the external and internal radii of the tube, W the water equivalent of the calorimeter and contents, R the rate of rise of temperature in degrees per sec. at the temperature of the room, θ_a the temperature of the outside, and θ_b that of the inside of the tube, then K, the thermal conductivity, is given by the equation—

$$K = [RW/2\pi l(\theta_b - \theta_a)] \log_e (a/b),$$

or approximately by—

$$K = [RW/\pi l(\theta_b - \theta_a)] [(a - b)/(a + b)].$$

θ_a is practically identical with the temperature shown by the thermometer in the calorimeter when the water is well stirred, and θ_b may be taken as the temperature of the steam passing through the tube. A. W.

1362. *The Radiation from and the Melting-points of Palladium and Platinum.* **C. W. Waidner** and **G. K. Burgess.** (Bureau of Standards, Bull. 3. pp. 163–208, May, 1907.)—The authors give the results of experiments on the melting-points of palladium and platinum. These points were determined by three distinct methods. (1) The *black-body method* in which the temperature of melting within an electrically-heated iridium furnace is measured with an optical pyrometer. (2) The *surface-radiation method* in which the black-body temperature of electrically-heated ribbons of these metals is measured at the instant of melting. (3) The *thermoelectric method* based on extrapolation by several formulæ. Ten thermo-couples of the following types were used: Pt, 90Pt-10Rh; Pt, 90Pt-10Ir; 90Pt-10Rh, 80Pt-20Rh; Ir, 90Ir-10Ru. The precautions necessary in the construction and use of an experimental black body to give ideal black-body radiation are described at length. It was found possible to construct a black body in which the temperature distribution at 1,800° C. was constant within 1°

throughout the greater part of the radiating enclosure. Five pyrometer lamps were calibrated by comparison with thermo-couples up to 1,800° C., using this uniformly heated black body as radiating source. The relation between the black-body temperature t and the current I through the lamps is represented by an equation of the form $I = a + bt + ct^2$ with a maximum inaccuracy of less than 1·5°. The Wien equation giving the relation between the absolute temperature of a black body and the intensity of any monochromatic radiation is assumed in the first method. The effect of a lack of monochromatism of so-called monochromatic glasses on temperature measurements is investigated as well as the effect of the polarisation of the light emitted by palladium and platinum on the absorption-coefficient of the mirrors. The results of the experiments by the black-body method are summarised in the following table:—

$t_1 = T - 273° =$ the observed black-body temperature.
$K =$ the absorption coefficient of the screen used.
$\lambda =$ the wave-length of light in microns.
$c_2 =$ the constant in the equation—

$$\log K = [(c_2 \log e)/\lambda](1/T_1 - 1/T_2).$$

$t_2 = T_2 - 273° =$ the calculated temperature of the melting-point.

MELTING-POINTS BY BLACK-BODY METHOD.

I. PLATINUM.

Group.	t_1 obs.	t_2 calc.	K.	λ.	c_2.	No. of obs.	Remarks.	Melting-point.
a	1,242	1,745	35·5	0·668	14,500	10	Sector disc and Wien's equation.	1,745°
b	1,310	1,740	"	0·547	"	6		
c	1,365	1,741	"	0·462	"	4		
d	1,080	1,746	199	0·668	"	16	Absorbing mirrors and Wien's equation.	
e	1,155	1,744	228	0·547	"	7		

II. PALLADIUM.

Group.	t_1 obs.	t_2 calc.	K.	λ.	c_2.	No. of obs.	Remarks.	Melting-point.
a'	985	1,540	200	0·666	14,500	8	Absorbing mirrors and Wien's equation.	1,540°
b'	984·5	1,539	"	"	"	7		
c'	1,124·5	1,540	35·5	"	"	11	Sector disc and Wien's equation.	

The melting temperatures estimated by thermoelectric extrapolation differ very considerably, depending on the formula and calibration data used. The two types of formulæ (i) $E = a + bt + ct^2$ and (ii) $E = mt^n$, which agree to within 2° up to 1,200° for the usual 10 per cent. Pt-Rh and Pt-Ir couples were compared at the melting-points of Pd and Pt for the four types of couple mentioned above. The usual 10 per cent. Pt-Rh and Pt-Ir couples give by (i) 1,580° and 1,706° and by (ii) 1,543° and 1,731°, respectively, for the melting-points of Pd and Pt. The other types of thermo-couples give results differing 25° or more from these values. Harker, using (i) and several types of thermo-couples, found 1,710° for the melting-point of Pt. Nernst and v. Wartenberg, using the black-body method, found 1,750°, and Holborn and Valentiner 1,789. The latter have found 14,200 as the value of c_2 in the Wien equation, and the former 14,600. The value the authors used above was based on the experiments of Lummer and Pringsheim. The value 14,600 when adopted in the "*a*" experiments quoted above would make the melting-point of Pt 1,740°, and the value 14,200° would make it 1,756°. The probable values of the melting-points of Pd and Pt the authors consider to be 1,546° C. and 1,753° C. respectively. The authors are making further experiments and are using the Stefan-Boltzmann law, as it is more satisfactory from the theoretical point of view. A. R.

1363. *Temperature Determinations by Two Thermo-couples.* (D.R.-P. 184,455. Centralblatt Accumulatoren, 8. pp. 102–103, July 5, 1907.)—In order to minimise the errors arising from the difference of temperatures between the furnace and the room, G. A. Schultze and A. Koepsel use two thermo-couples, approximately of the same e.m.f.'s, x and y, at room temperature, instead of one couple, and apply a compensation method. The two couples are so joined to a high resistance W, of which a slider cuts off an adjustable portion r, that the e.m.f.'s $y/x = r/\mathrm{W}$. To each ratio y/x corresponds a definite temperature. H. B.

1364. *High Vacua and Helium at Low Temperatures.* **J. Dewar.** (Engineering, 83. pp. 781–782, June 14, 1907. *Résumé* of lecture delivered before the Royal Inst., June 7, 1907.)—After references to the liquefaction and solidification of hydrogen and attempts at the liquefaction of helium, the marvellous absorptive power of charcoal at low temperatures was illustrated in various striking ways. In absorbing the gases the charcoal, of course, becomes heated, and this heat the author measured in his liquid-air and hydrogen calorimeters. The direct value found for the molecular latent heat of hydrogen in the liquid-air calorimeter was 4·6 × 426 cals., and for helium the value 4·6 × 105 cals. at 18° absolute was deduced. From a comparison of these figures for various gases with the calories evolved when the gases were absorbed by charcoal we could infer that helium would be absorbed by charcoal at a temperature of 5 or 6° C. abs. as freely as hydrogen was absorbed by charcoal at its own boiling-point, and that, therefore, the boiling-point of helium should be about 6 or 5° C. absolute. It was then shown that a Crookes' radiometer containing helium as residual gas remained quite inert when exposed to the beam of an electric arc, because the gas was not sufficiently rarefied. Immersing the charcoal tube attached to the bulb in liquid air made no difference; but when the tube was immersed in liquid hydrogen the radiometer began to spin rapidly, and when the hydrogen was pumped from its cylinder, so as to boil violently and to solidify partly, after turning opaque, the radiometer still continued to rotate, showing that not much of the helium was condensed even at a temperature of about 13° abs. The McLeod gauges were hardly suited for measuring the extreme vacua of these investigations. It accordingly occurred to the author to re-examine the Crookes' radiometer in order to see whether it could not be utilised for indicating that the gas pressure had sunk below a certain minimum limit at which it would spin. What was aimed at, therefore, was to "kill" the radiometer. That this was possible was demonstrated in several ways. One radiometer refused to spin when exposed to an arc beam of 2,000 candles, because the vacuum was too good; when the vacuum was spoiled by introduction of more helium, the radiometer began to spin. E. H. B.

1365. *Maximum Pressure of Aqueous Vapour.* **A. Leduc.** (Comptes Rendus, 144. pp. 1259–1261, June 10, 1907.)—By his so-called molecular volume method [see Abstract No. 1491 (1899)] the author has calculated 1,700 c.cm. as the specific volume of saturated steam at 99·6° C. Assuming with Ames [Abstract No. 1297 (1901)] the latent heat at this temperature to be 536·9 mean calories per gm., and $4{\cdot}186 \times 10^7$ as the value of J, we get from Clapeyron's formula for this temperature $dp/dt = 2{\cdot}662$ cm. of mercury, which is less by over 1 per cent. than Regnault's direct determination, but is confirmed by Chappuis' formula for the saturation-pressure of water near 100°, viz., $t = 59{\cdot}8465 + 0{\cdot}6854624p - 0{\cdot}00206746p^2$, which gives 2·66214, and also by some experiments which gave 2·663, temperatures being all reckoned on the hydrogen scale. It thus appears that calculations by the molecular volume method give better results than direct observations, and the assumption which underlies the calculation, viz., that steam belongs to the *normal* series of vapours in regard to corresponding states, seems to be confirmed. [*Erratum*, ibid. p. 1396.] R. E. B.

1366. *Variation of Pressure due to Explosion of Cordite in Closed Vessels.* **C. H. Lees** and **J. E. Petavel.** (Roy. Soc., Proc. Ser. A. 79. pp. 277–285, June 8, 1907.)—Petavel has deduced from Noble's observations [see Abstracts Nos. 733 and 734 (1906)] that the maximum pressure P developed by the explosion of mass M of cordite, of volume v_0, in a closed vessel of volume v is given by $P = cM/(v - v_0)$, where c is a constant. Assuming from this result that the pressure p at any time t is proportional to the mass of cordite consumed up to that moment, and, further, that cordite when once ignited burns in parallel layers, the authors find by plotting the results of thirteen experiments that the relation between the speed of combustion $-dr/dt$ and the pressure p is linear, r denoting the radius of the cordite cylinder. Conversely, if the relations $-dr/dt = a(p + \pi)$ and $p = p_0 + P(1 - r^2/R^2)$ are assumed, where p_0 is the initial pressure and R the initial radius of the cordite, it is easy to show that the time required for complete combustion is $T = R/Pa\kappa \tanh^{-1}\kappa$ where $\kappa^2 \equiv 1 + (p_0 + \pi)/P$, and that the pressure at any time is given by $(p + \pi)/P\kappa^2 = \operatorname{sech}^2[(1 - t/T)\coth^{-1}\kappa]$, from which it follows that the maximum value of dp/dt occurs for $(p + \pi)/P\kappa^2 = \frac{2}{3}$ [or $t/T = 1 - \operatorname{cosech}^{-1}\sqrt{2}\tanh^{-1}\kappa = 1 - 0{\cdot}6585 \tanh^{-1}\kappa$], being equal to $4P^2\kappa^3 a/3\sqrt{3}R$. These formulæ reproduce exactly what is observed when $R = 2{\cdot}22$ mm., and also for $R = 0{\cdot}445$ mm. if a time-allowance of 0·0013 sec. is made (which may well be done as ignition does not occur immediately on firing), and they satisfy the observations in other respects also, so that the theory may be used to predict what will occur outside the range of observation. For cordite Mark I the value of $a\kappa \tanh^{-1}\kappa$ is found to be about 1/72 when R is measured in cm. and P in atmos. It is noted that T varies as R [but for this we must have M constant; otherwise $T \propto R/M$ or $(LR)^{-1}$ approximately, L being the length of the cylinders]. R. E. B.

1367. *Condensation of Water-vapour on Glass Surfaces.* **F. T. Trouton.** (Roy. Soc., Proc. Ser. A. 79. pp. 383–390, July 10, 1907.)—The work of a former paper [see Abstract No. 914 (1906)], with glass wool as the condensing substance, and with arrangements for drying it, is continued. Into the bulb containing this wool, which had been thoroughly dried, equal small charges of water were fed at intervals of at least three days, and the resulting pressures were measured when equilibrium was established. The pressure-curve was found to differ from that obtained before with ordinary wool in having (1) an initial steep rise, (2) a bend like that in J. Thomson's suggested isothermal for a fluid, rapid condensation occurring when the pressure becomes roughly about half that of saturation and suggesting a state of supersaturation. From this action it appears possible to arrange a relatively wet surface so as to act as a drying agent to a surface drier than itself. If the glass-wool is initially dried for a time only just sufficient to reduce the vapour-pressure to zero, the pressure-curve is shaped at its start like that noted with ordinary wool, *i.e.*, tangentially to the feed-axis, but the bend afterwards makes its appearance. It thus appears that there are two modes in which the molecules of water in condensing can arrange themselves on the surface of the glass. An explanation of this action is deduced from consideration of J. Thomson's isothermal, and certain phenomena are described and explained; *e.g.*, of two portions of phosphorus pentoxide in a drying tube one may be quite wet while the other is practically dry. The variation of pressure within a vacuum discharge tube which seems to depend on the treatment of the tube can also be accounted for. The question of the two possible states in which vapour can condense on solid surfaces, and also the dependence on temperature of the critical pressure at which supersaturation occurs are being further examined. R. E. B.

1368. *Irreversible Transformations. Entropy.* **A. Ponsot.** (Journ. de Physique, 6. pp. 505–530, July, 1907.)—By certain reasonings the author is led to formulate the following ideas among others. (1) Every body possesses free entropy which increases when the kinetic energy of its particles or electric charges is wholly or partially destroyed; (2) when kinetic energy is destroyed at a point of a body, there is an increase of this entropy, a creation of free entropy to gather together the heat-energy that results from this kinetic energy and numerically equal to this heat-energy divided by the absolute temperature at the point considered; (3) when entropy is ceded to a body a rise of temperature results dependent on the amount of work done simultaneously by the body; (4) no variation of free energy attends adiabatic alteration of volume of a body, whether accompanied by change of physical or chemical state or not, but the consequent change in entropic capacity entails change of temperature; (5) two bodies are in entropic equilibrium when their temperatures are the same; otherwise a quantity of entropy with the energy it possesses passes from the one to the other, part of this energy being employed initially to move the entropy and assuming the form of heat when this motion is over, free entropy being thereupon created to receive the heat-energy thus formed. R. E. B.

1369. *Establishment of the Thermodynamic Scale of Temperature.* **E. Buckingham.** (Bureau of Standards, Bull. 3. pp. 237–293, May, 1907.)—The theory of the constant-volume and constant-pressure gas thermometers, as based on the Joule-Thomson effect, is first of all developed in the usual way, but emphasis is laid on the different nature of the experimental data most suitable for connecting these scales with the thermodynamic scale; the best available experimental data regarding densities, specific heat, and expansion-coefficients are then quoted; next the numerical values of the Joule-Thomson effect found by different experimenters are examined, and it is shown that by the use of the law of corresponding states all the values may be co-ordinated and represented by a single empirical equation from which, by an inverse process, values may be obtained which are probably more exact than any that can be deduced from the observations on each gas separately. This equation is $\mu' = 0{\cdot}555\,(\tau' - 0{\cdot}42)^{-1} - 0{\cdot}008\,(\tau' + 6{\cdot}81)$, where

μ' and τ' are the "reduced" cooling effect and temperature, and it, as well as simpler approximations, are utilised in integrating the equations of the constant-pressure thermometer. The thermodynamic temperature of the freezing-point of water is computed in several ways and the value 273·18° finally deduced. The corrections needed to reduce the readings of the constant-pressure hydrogen and nitrogen thermometers are then computed and compared with those obtained by others; the lack of concordance in the case of hydrogen indicates the need of further experiments on this gas, but in the case of nitrogen the comparison is satisfactory, and the thermodynamic temperature of the boiling-point of sulphur comes out as 444·9°. The relation of the constant-pressure and constant-volume scales is finally discussed, the corrections for the latter being deduced from those of the former and, in the case of hydrogen, being found to be practically negligible.

R. E. B.

REFERENCES.

1370. *Specific Heat of Superheated Steam.* **S. B. Bilbrough.** (Eng. Rev. 16. pp. 433–435, June, 1907.)—Smith's criticisms of the author's paper [see Abstracts Nos. 433, 677 (1907)] are partly founded on misinterpretation; the experiments giving the high values of K near saturation are the most accurate ones; the errors attending the throttling method are on the whole too small to affect the thermometer.

R. E. B.

1371. *Vapour Pressure of Solid CO_2.* **H. du Bois.** (Phys. Rev. 24. p. 445, May, 1907.)—The slight differences between the author's results [see Abstract No. 74 (1900)] and those lately obtained [see Abstracts Nos. 1887 and 2048 (1906)] are assigned to possible variations in the commercially produced CO_2 employed by all the investigators, and repetition of the observations with specially purified CO_2 is advocated. R. E. B.

1372. *Entropy of Partially Coherent Beams of Radiation.* **M. Laue.** (Ann. d. Physik, 23. 1. pp. 1–43, May 28, 1907.)—Deals with the entropy of associated beams; incident, reflected and refracted, also beams emitted by self-luminous bodies. The treatment is highly analytical. [See Abstract No. 1416 (1906).] E. H. B.

SOUND.

1373. *Absolute Sensitiveness of the Ear.* **H. Abraham.** (Comptes Rendus, 144. pp. 1099–1101, May 21, 1907.)—By experiments with a telephone and alternating currents of frequencies 250 and 500 per sec. determinate pressure variations are produced at the ear. The telephone was standardised by steady currents, and the relation between current and pressure ascertained. The experiments lead to the conclusion that the normal ear can respond to a pressure variation of about four ten-millionths of a millimetre of mercury. E. H. B.

1374. *Consonance of Two Simple Tones.* **K. v. Wesendonk.** (Phys. Zeitschr. 8. pp. 452–454, July 1, 1907.)—Simple tones of full intensity and well sustained were obtained by blowing into a glass tube or bulb of special form, open at the top and filled to an adjustable level with water. Elaborate precautions were taken to keep the blast and all other conditions constant after adjusting the pitch to a fork of 1,000 per sec. A like arrangement gave a tone of exactly 700 in unison with a fork. Then the two glass bulbs were sounded together and blended well, giving the differential tone of 300. Similar results followed when frequencies of 500 and 700 were used. When the 1,000 and 700 were sounded together and the 700 was gradually changed to 666·66 so as to form the musical fifth, the consonance was not appreciably improved. E. H. B.

1375. *Durations of Primary and First Overtones of Tuning-forks.* **M. T Edelmann.** (Phys. Zeitschr. 8. pp. 451–452, July 1, 1907.)—Bezold has an A-fork (108·8) in which the peculiarity is noticeable that the prime tone can be heard for more than 100 sec., while the first overtone lasts only a very short time. In the case of a copy of this fork in which only the stem was somewhat different in form, the first overtone lasted over 50 sec. The reasons for this difference in behaviour are traced to the nearness together of the various tones to be obtained in different positions and when supported in various ways. E. H. B.

1376. *Simple Demonstration of Vibrations in Air Column.* **M. Seddig.** (Phys. Zeitschr. 8. pp. 449–451, July 1, 1907. Phys. Inst., Marburg, April, 1907.)—The organ-pipe is laid horizontally and provided with several holes on the upper side. These are fitted with caoutchouc membranes and covered with a 2-mm. thick layer of water and glycerine mixture in the ratio 4 : 3. Light from an arc lamp is then directed downwards on to these liquid surfaces which reflect it on to a screen. On sounding the pipe and illuminating the liquid reflectors, each is found to exhibit on the image the state of things at the place in question. Nodes, antinodes, and intermediate positions are thus clearly distinguished. E. H. B.

REFERENCE.

1377. *Submarine Signalling.* (West. Electn. 40. pp. 570–571, June 29, 1907.)—Describes an electromagnetic transmitter designed by L. I. Blake to be used by ships for submarine signalling by sound waves in the water. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1378. *Action of Uniform Electric and Magnetic Fields on Moving Electrons.* **A. H. Bucherer.** (Phil. Mag. 13. p. 721, June, 1907.)—In a recent paper [see Abstract No. 1048 (1907)] the author calculated the forces on moving electrons in the uniform fields of electromagnets and of condensers, but omitted to point out there that the expressions obtained do not apply to all kinds of uniform fields. In fact, since the forces on the electrons depend primarily on the distribution of electric and magnetic masses and only *indirectly* on the fields, it follows that electrons in fields of the same intensity may experience different forces; further, that solenoids must be replaced by equivalent magnetic shells; and, lastly, two fields superimposed are not replaceable by their resultant. E. H. B.

1379. *Measuring Vertical Electric Currents in the Atmosphere.* **H. Gerdien.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 77–85, 1907.)—The observations are made at Göttingen, the potential gradient being determined with a registering Benndorf electrometer, the specific conductivity with the author's apparatus [Abstract No. 2078 (1905)], and the ions counted with the aid of an Ebert apparatus modified for the author by Spindler and Hoyer. Other meteorological observations, including turbidity of the air, were taken simultaneously, and anticyclonic conditions selected in order to eliminate the convection currents. The density of the vertical current, *i.e.*, the product of potential gradient and of the conductivity λ, must be constant where the density of the charge does not vary, and it would appear that the changes in the potential gradient sometimes accompanying a stationary condition of the vertical currents must be due to changes in the conductivity. The resulting mean density of the vertical current is $8{\cdot}000 \times 10^{-7}$ electrostatic unit; the conductivities for positive and for negative ions differ little from one another, $\lambda_p = 1{\cdot}155 \times 10^{-4}$, $\lambda_n = 1{\cdot}120 \times 10^{-4}$, the velocities of the ions are $v_p = 326$, $v_n = 394$ electrostatic units (or 1·09 and 1·31 cm. per sec./volt per cm.), and the ionic charges $E_p = 0{\cdot}354 \times 10^{-6}$, and $E_n = 0{\cdot}287 \times 10^{-6}$. To the latter values the author attaches little weight, as the apparatus counts only a small portion of the ions contained in the air. The means are based on about fifty measurements in each case. H. B.

1380. *Radiation from Moving Systems of Electrons, and Spectrum of Canal Rays.* **G. A. Schott.** (Phil. Mag. 13. pp. 657–687, June, 1907.)—In a previous article the author examined the radiation from a stationary ring of electrons, which are in orbital motion in a suitable controlling field, and also from a system composed of a large number of similar independent rings [see Abstract No. 449 (1907)]. A ring of *n* electrons emits 6*n* waves of frequencies of the same order as those of spectrum lines; but of these waves at most 18 are of sufficient intensity, under ordinary conditions, to produce observable lines. Thus we cannot, by means of a single ring, account for a complete spectrum series or band; but we may be able to do so by means of a system of rings coupled together by their mutual actions. For this purpose the study of the single ring is necessary.

In a series of experiments J. Stark has shown [see Abstract No. 708 (1906)] that the canal-ray spectrum contains series lines, each line being split up into a narrow undisplaced line, due to nearly stationary ions, and a broad displaced line due to ions moving with velocities ranging from 10^7 to 5×10^7 cm./sec. The latter is separated by a dark space from the former, and has a maximum of intensity, which increases with the velocity, and that more rapidly for high-frequency lines. Mainly because of the dark space, he considers that the energy radiated in the displaced line is transformed from kinetic energy of translation, not by the agency of collisions, but by the direct action of radiation-pressure. The energy radiated in the undisplaced line is attributable directly to collisions. He formulates the question: "Given a system of electrons in orbital motion, so arranged that their radiation into the external medium is mutually compensated; does the compensation subsist when the system is given a motion of translation through the ether?"

The present theoretical investigation supplies an answer to this question. For a uniform translation it is in the affirmative, in so far as no periodic waves are emitted in consequence of the motion; for non-uniform motions periodic waves are emitted when the changes in velocity and orientation of the system are rapid enough. It is further shown here that the radiant energy cannot be due to radiation-pressure, since the work done by that pressure is but a very small fraction of the energy radiated. The rest of the paper is devoted to a brief discussion of Stark's experimental results in the light of the theoretical conclusions arrived at in the first portion of the paper. E. H. B.

DISCHARGE AND OSCILLATIONS.

1381. *Electrical Conductivity produced by Heating Salts.* **A. E. Garrett.** (Phil. Mag. 13. pp. 728–747, June, 1907. Paper read before the Physical Soc., April 26, 1907.)—The experiments here described form a continuation of those by R. S. Willows and the author, on the halogen compounds of zinc. The chief conclusions now reached may be summarised thus. (1) Many inorganic compounds when heated up to temperatures below 360° C. have the power to produce electrical conductivity. (2) In the case of some of these compounds (*e.g.*, halogen salts of zinc) chemical changes take place and the conductivity produced has its origin in these changes. The ions so produced are similar to those which have been observed in the cases of recently-prepared gases and the conductivity produced by phosphorus. (3) In all cases the ions are of a large size, as is shown by their relatively small velocities. They probably consist of a charged centre surrounded by particles produced from the heated compound, and in some cases water vapour. Their nature could be best determined by finding e/m, but means for producing a strong enough magnetic field were not available. (4) The presence of water is in some cases intimately connected with the conductivity produced, as is shown by (*a*) the difference in behaviour of ordinary and carefully dried compounds, (*b*) the change in the rate of decay after heating for some time. (5) In some of the more active substances, *e.g.* halogen compounds of zinc, increased conductivity can be readily detected in air at ordinary temperatures and pressures. 6) The ions, both negative and positive, have only a very low velocity, similar to those which have been observed in the cases of phosphorus, recently-prepared gases, and gases from flames. This velocity is greatly increased by a rise in temperature. The product, pressure × velocity, is constant for certain ranges of pressure. (7) The rate of leak at different temperatures can be represented in all the cases tried by a formula of the form $I = a\,\theta^{\frac{1}{2}}\,e^{-b/\theta}$, in which a and b are constants, θ is the absolute temperature, and I is the saturation current. (8) The ions produced are not able to penetrate a layer of aluminium 0·0008 cm. in thickness. E. H. B.

1382. *Secondary Kathode Rays.* **J. Laub.** (Acad. Sci. Cracovie, Bull. 2. pp. 61–87, Feb., 1907. Ann. d. Physik, 23. 2. pp. 285–300, June 18, 1907. Extract of Dissertation, Würzburg. Écl. Électr. 52. pp. 90–93, July 20, 1907.)—Kathode rays strike a metal enclosing the bulb of a sensitive thermometer: the rays are conducted to earth through a galvanometer. The current i, so produced, is measured for different angles of incidence of the rays, and at the same time the energy Q, generated in the metal, is measured by the thermometer. As the angle of incidence is increased, i decreases and finally changes sign. This is due to the emission of secondary kathode rays which increase in amount as the incidence augments. As the velocity of the primary rays increases it is found that the secondary rays decrease in amount. These effects are the more marked the heavier the metal. If the secondary-ray velocity is the same as the primary, then when $i = 0$, Q also should be zero, and when i changes sign so also should Q. The experiments show that Q is independent of the angle of incidence; hence it is concluded that the velocity of the secondary rays is small, and that the amount of the rays undergoing reflection is also independent of the angle of incidence. A theory of these results is given. R. S. W.

1383. *Fatigue of Metals under Röntgen Rays.* **L. T. More.** (Phil. Mag. 13. pp. 708–721, June, 1907.)—Photo-electric fatigue was studied in iron, lead, nickel, zinc, copper, and aluminium. All these metals, with the possible exception of Cu and Al, experience a fatigue when subjected to Röntgen rays for several hours, if their surfaces are not polished. The greatest diminution of activity is shown in Fe and Zn, amounting to about 10 per cent. after 8 hours' exposure. The fatigue is not a permanent effect, as the plates recover their original sensitiveness after a comparatively short rest. The effect of immersing polished plates in coal-gas, which would probably form sulphides on the surface, is not noticeably different from the action in air. An inert gas, like hydrogen, apparently tends to prevent changes in activity. When ozone is added to the air surrounding polished iron and copper plates, a considerable fatigue occurs, but not comparable to the effect noted by Hallwachs. The author does not go so far as to support the disintegration theories of Allen, Ramsay, and Spencer, but thinks that the simpler idea of changes in the absorptive power of electrified double layers and other films of dense gas near the surface of the metals is the probable cause of fatigue. E. E. F.

1384. *Photo-electric Fatigue in Alkali Metals.* **K. Bergwitz.** (Phys. Zeitschr. 8. pp. 373–378, June 1, 1907.)—Investigations were made to test the behaviour of sensitive cells whose negative poles were formed of the metals, sodium, potassium, and rubidium, pure and in the solid state. The cells were of the type set up by Elster and Geitel, the anode consisting of an Al wire, and both electrodes being sealed up in a vacuum. Researches were also made on cells whose kathode was a liquid alloy of K and Na. The special object of the investigation was to find if any photo-electric fatigue could be observed with these cells. The source of light used was a Nernst lamp. The following are the results of the inquiry: (1) Under the action of visible light no fatigue is observed in the case of the cells referred to. (2) The Elster and Geitel potassium-sodium cells whose surface is sensitive to light, and can be renewed in the vacuum, do not become insensitive with lapse of time. (3) The current set up in a photo-electric cell by visible light can be made use of to set in vibration the membrane of a sensitive telephone.

J. J. S.

1385. *Influence of Temperature on the Photo-electric Discharge from Platinum.* **W. M. Varley** and **F. Unwin.** (Roy. Soc. Edinburgh, Proc. 27. pp. 117–134, 1906–1907.)—The authors consider Zeleny's results difficult to interpret on account of the presence of gas, since the experiments were performed at atmospheric pressure [Abstract No. 1919 (1901)]. They have therefore measured the photo-electric currents from platinum up to about 500° C. in air, CO_2 and hydrogen, at three pressures: (1) Atmospheric pressure; (2) about 46 mm.; (3) in a very high vacuum. It is found that even in the highest vacua an increase in e.m.f. produces a slight increase in current, but this is too small to influence the numbers in these experiments appreciably. The Pt-foil is heated by a current, and its temperature measured by a thermo-junction. In air and CO_2 at atmospheric pressure, as the temperature is raised, the photo-electric current sinks to a minimum and then rises again; the temperature of minimum current is about 400°. The curves for air and CO_2 can be made to coincide. In hydrogen the current increases steadily as the temperature is raised. In the first two gases, and to a much less extent in hydrogen, time is required for the photo-electric current to reach its final value, and on reducing the temperature to that of the atmosphere many hours may elapse before the current returns to its original value. If in air or CO_2 the temperature reached is greater than 400° a large increase in the photo-electric activity results, the current at 14° being twice as great after heating as before; it slowly decays to its original value. This cannot well be accounted for by an absorption of gas, since CO_2 is not known to be absorbed by Pt. It is therefore ascribed to a change in the surface of the metal. The results at 46 mm. pressure are very similar. At low pressures the behaviour of platinum is, to a large extent, independent of the nature of the gas. A comparatively small heating current increases the activity to a maximum value, beyond which no further increase can be obtained. The sensibility slowly decreases with time when the heating current is turned off.

R. S. W.

1386. *The Determination of Potential by Carbon Pencils.* **C. D. Child.** (Phys. Rev. 24. pp. 498–507, June, 1907.)—The author proves that appreciable errors are often made when the potential of gases is determined by carbon pencils. He has previously shown that when the temperature of carbon in air is gradually raised it first discharges positive electricity, then both kinds of electricity, and finally it discharges more negative than positive. Elster and Geitel have shown [Wied. Ann. 31. p. 109, 1887] that if there is no external e.m.f. between a Pt wire and a neighbouring insulated body, the wire is positive to the other body when it first becomes luminous, but negative when it becomes white-hot. The author finds that the same phenomenon occurs with carbon. This leads him to modify some of the conclusions he had deduced in a previous paper on the magnetic deflection of the arc [Abstract No. 1030 (1905)]. When the arc is deflected to one side by a magnet it is probably incorrect to say that the side towards which it moves assumes a higher potential than the other. The alteration of the potential of carbon pencils with temperature will probably also make it necessary to modify the conclusions of other experimenters. The phenomena observed by Stark, Retschinsky, and Schaposchnikoff [see Abstract No. 146 (1906)] in attempting to determine the relative velocity of the ions of the carbon arc in air were more probably due to this cause than to differences in the velocities of the ions. Similarly the phenomena observed by Swinton (Abstract No. 147 (1906)] were probably due to the diffusion of the ions in the arc, and not to any anode or kathode rays. We may conclude, therefore, that no definite determination of the relative velocity of the ions in the carbon arc in air has yet been made. A. R.

1387. *Photo-electric Effect and Conductivity.* **W. Wilson.** (Ann. d. Physik, 23. 1. pp. 107–130, May 28, 1907. Extract from Inaug.-Dissertation, Leipzig.)—It is shown that silver-iodide is about ten times as active photo-electrically as aluminium for ultra-violet rays. Violet rays, on the other hand, cause no photo-electric currents, although light of this wave-length is strongly absorbed, and, according to Scholl, produces conduction in the substance [Abstract No. 1135 (1905)]. Ultra-violet rays also produce conduction in the substance, but this effect is considerably smaller than for the violet. These differences are explained if the internal conduction is due to slowly-moving ions, while the discharging effect caused by the ultra-violet rays is caused by ions of great velocity. A layer of granular silver becomes a better conductor when exposed to ultra-violet radiation, and also shows an increased discharging effect. Experiments with shellac give no discharge effects with ultra-violet light. This may be due to its transparency to these rays.
R. S. W.

1388. *Velocity of Metallic Particles in Spark Discharge.* **A. Schuster.** (Astrophys. Journ. 25. pp. 277–279, May, 1907.)—Experiments by G. F. Hull [Abstract No. 638 (1907)] have been cited as at variance with the conclusions found by Schuster and Hemsalech in their work on spark discharges [Abstract No. 1066 (1900)]. Schuster now says there is no real connection between the two sets of experiments. Schuster and Hemsalech measured the velocities of metallic particles under certain conditions of spark discharge, whereas Hull failed to detect any displacement of lines corresponding to these velocities. In the first case strong single sparks from condensers were employed, while the latter apparently only examined sparks from an induction coil without secondary capacity. [See also Abstract No. 2104 (1906).] C. P. B.

1389. *On the Positive Luminosity and the Melde Experiment.* **P. Villard.** (Comptes Rendus, 144. pp. 834–836, April 22, 1907.)—In confirmation of the hypothesis [Abstract No. 982 (1906)] that the magnetic deviation of the positive light can only be explained by the analogy of a conductor, the author has found that the anodic column can be made to vibrate like a stretched cord, and give stationary waves quite comparable with those of the Melde experiment. In the experiments a high frequency (1,000 per sec.) was employed; also a high pressure (2 to 8 cm. of mercury). The screen effect of the walls of the tubes was thus suppressed, and the positive luminosity could be acted on from the outside of the tube while, at the same time, oscillating electrodes were used. D. H. J.

1390. *Passage of Electric Waves through Non-metallic Gratings.* **M. Laugwitz.** (Ann. d. Physik, 23. 1. pp. 148–162, May 28, 1907. Phys. Inst. d. Univ., Breslau, Dec., 1906.)—In this experimental research the electric waves are produced at the focal line of a parabolic mirror, and received at another mirror at whose focal line is a Klemenčič thermo-element. Diaphragms and the gratings under test were introduced between the mirrors. The gratings consisted of glass tubes containing water, acetone, and nitrobenzol respectively. The chief results may be summarised as follows: (1) The action of a grating consisting of liquids when used for Hertz waves is different from that of the usual wire grating in that it depends, not upon the conductivity of the material, but upon its higher dielectric constant; (2) such a grating is analogous to the dichroic crystals, and carries this analogy further than the wire grating, because the latter only outwardly imitates the phenomena, while the causes are certainly quite different from those in the crystals; (3) it is now experimentally shown for the first time that electrolytes of high conductivity in a region of Hertz waves can show resonance phenomena: the same holds for carbon also; (4) a new method of determining the dielectric constant is thus incidentally afforded since by using the liquid in question in tubes, and testing the power of such a grating to stop the waves, its value could be inferred. [See also Abstract No. 119 (1907).] E. H. B.

1391. *Thermo-electric Wave Detector.* **L. W. Austin.** (Phys. Rev. 24. pp. 508–510, June, 1907.)—The author has devised a detector which he considers operates on the thermo-electric principle. The elements employed are tellurium and aluminium. A tellurium bead melted on to the end of a brass spring wire bears against a pointed aluminium rod, the contact pressure being regulable; in another form of construction the aluminium point is made to rotate. Comparison with the electrolytic detector by the shunted telephone method shows it to be of about the same sensitiveness. An applied alternating current of value between 10^{-6} and 8×10^{-7} amp. produces a direct current of intensity about 10^{-9} amp. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1392. *Variation of Manganin Resistances with Humidity.* **E. B. Rosa** and **H. D. Babcock.** (Electrician, 59. pp. 339–342, June 14, 1907. Paper read before the Amer. Phys. Soc., April 21, 1907. Electrical World, 49. pp. 1302–1305, June 29, 1907. Écl. Électr. 52. pp. 143–144, July 27, 1907.)—Manganin resistances do not remain entirely constant in value, and the variations occur in the most carefully prepared standards of the Reichsanstalt form as well as in the resistances of potentiometers, resistance boxes, &c. During an investigation by the authors it was found that all the resistances employed had a higher value at the same temperature in summer than in winter, the change being a gradual drift upward from early spring to midsummer, followed by a steady drift back to the same minimum in the winter. The amplitude of the change was from 15 to 25 parts in 100,000. Most of these resistances were kept in oil, but some were in air. It was found that changes such as occurred during an interval of six months in the atmosphere of the laboratory could be induced in a few days by placing the resistances in a closed case in which an atmosphere of high humidity was maintained, although it usually required several weeks for the resistance of a coil to reach a maximum, or to return to its former value when restored to the original condition of humidity. The suggested cause of the increase in resistance of the coils is that the shellac, in which the wire is embedded, absorbs moisture from the surrounding atmosphere and expands, stretching the manganin wire and thereby increasing its resistance. When the atmosphere is drier the shellac gives up moisture and shrinks, and the wire also contracts and its resistance decreases. Dipping the coils in melted paraffin wax will seal them effectually against moisture, so that even the finest wire remains of constant resistance. The authors give a number of curves showing the seasonal change of certain resistances during two years; also other curves indicating constancy of resistance when the humidity is kept constant.

F. E. S.

1393. *Thermo-electric Coils.* **B. Lasgoity.** (Écl. Électr. 52. pp. 42–45, July 13, 1907.)—It is known that the permeability of iron varies with the temperature, and hence if we keep the magnetomotive force of a solenoid with an iron core constant and vary the temperature a current will flow in a circuit linked with the magnetic flux. Easy experiments can be devised to illustrate this. The following experiment illustrates how rotation can be produced by this change in the permeability. A number of little iron strips are placed so as to form the spokes of a little wheel capable of rotation about a vertical axis. The ends of the spokes pass near a horseshoe magnet. On heating with a spirit lamp the strip next the magnet its permeability diminishes, and thus a neighbouring strip is attracted more powerfully and rotation ensues as the strips get heated by the lamp in turn owing to the rotation. Possible industrial applications of the principle are discussed.

A. R.

1394. *Effect of a Transverse Magnetic Field on Metallic Resistance.* **E. P. Adams.** (Phys. Rev. 24. pp. 428–435, May, 1907.)—The effect of a transverse magnetic field in changing the resistance of a conductor has been investigated by many observers; Patterson and Grunmach [see Abstracts Nos. 110 (1903) and 115 (1907)] have measured the effect in a number of metals, and the agreement between their results is on the whole very good. A theory of this effect has been given by J. J. Thomson [Abstract No. 1555 (1902)], who assumes that the electric current is carried by free corpuscles which behave just as molecules of a gas, except that the collisions which occur are not between corpuscles and corpuscles, but between corpuscles and atoms of the metal. Electric force causes a drift of the corpuscles in one direction, which is the electric current. In the present paper the author develops J. J. Thomson's theory and introduces a modification by considering the effect of the magnetic field on the molecular configuration of the metal. In this way he finds it possible to explain the sign of the effect in the ordinary para- and dia-magnetic metals, and in the ferromagnetic metals as well. Thomson's unmodified theory can be made to apply to the ferromagnetic metals only by assuming that in them the collisions are of an altogether different character from the collisions in other metals. The author discusses mathematically the motion of the corpuscles in a magnetic field and notes Thomson's view that the collisions between corpuscles and atoms are strongly influenced by the electric charges carried by the corpuscles. This would point to an increase of resistance due to the magnetic field. If now it is assumed that a magnetic field produces a rearrangement of the molecules within a metal, it seems reasonable to assume that the free path of a corpuscle will be altered. For the ordinary para- and dia-magnetic metals, for which the magnetic susceptibility appears to be constant and independent of the strength of the magnetic field, the change in the configuration must be supposed to increase with the magnetic field. Thus if these metals show an increase in resistance for certain values of the magnetic field, their resistance should increase in all magnetic fields, however great. This is the result found by experiment. For the ferromagnetic metals the case is different. Magnetic saturation occurs and, beyond a certain limit, on increasing the magnetic force no more change in the molecular configuration is produced, and hence no further change in the free time of a corpuscle. The alteration necessary in the mathematical equations of motion in order to express their difference of behaviour introduces a result which indicates a decrease of resistance due to the magnetic field. This is the result obtained by Grunmach experimentally. A calculation based on Grunmach's experimental results for the case of iron leads to the value 3×10^{-13} as the order of magnitude of the free time of a corpuscle in iron, and it is probably not very different in other metals. From this follows the number of corpuscles per unit volume which are involved in the electric current, viz., 7×10^{21}. Calculation gives also for the length of the free path 3×10^{-6}. In crystalline bismuth the resistance is different in different directions, and it is suggested that this may be due to differences in the free paths of corpuscles in different directions in the metal. J. J. S.

1395. *Electrolytic Resistance and Capacity.* **A. H. Taylor.** (Phys. Rev. 24. pp. 402–406, May, 1907.)—A description of a new method for the determination of electrolytic resistance and capacity using alternating currents. In regard to its behaviour towards alternating currents, an electrolyte which has polarising electrodes may be regarded as a resistance in series with a capacity, a second resistance shunting both the resistance and the capacity in some cases. It is possible to balance this combination in a bridge by inserting a shunted inductance in the same arm with the shunted electrolyte. The bridge consists of two proportional arms, a and b, which are identical; the fourth arm consists of a variable non-inductive resistance R, and the third consists of a capacity C in series with a resistance r_2 and an inductance L of resistance r_4. A resistance r_3 shunts the inductance and a resistance r_1 shunts the capacity and r_2. The perfect balance condition means that: (1) $R = r_1 + r_3 r_4/(r_3 + r_4)$; (2) $r_1^2/r_3^2 = (r_1 + r_2)/(r_3 + r_4)$; (3) $C = L/ab = L/(r_1 + r_2)(r_3 + r_4)$. If C is an ordinary condenser, and L a variable inductance, it is easy to obtain a perfect telephonic balance, such that these three equations are satisfied. Equation (1) allows r_1 to be calculated. If the calculated value is smaller than r_1, as observed, it will indicate a leaky condenser action. Equation (2) allows r_2, the *effective* electrolytic resistance, to be calculated. Equation (3) is used for computing the capacity. F. E. S.

1396. *Measurement of Resistance and Capacity.* **G. Athanasiadis.** (Ann. d. Physik, 23. 2. pp. 392–394, June 13, 1907.)—The change advocated by the author is the substitution of direct current (from a dynamo) for alternating current in the generally used methods. Such a current from a dynamo is undulatory, and if a telephone of suitable resistance is inserted in the circuit a note of constant pitch is observed, the frequency of which depends on the number of commutator segments, &c., of the dynamo. It is thus easy to use such a current in the measurement of resistance and capacity, in which a telephone and alternating current are generally employed. The chief advantages claimed are rapidity of measurement and simplification of apparatus. F. E. S.

1397. *Resistance of Electrolytes in the Magnetic Field.* **G. Berndt.** (Deutsch. Phys. Gesell., Verh. 9. 12. pp. 240–242, June 30, 1907. Physikal. Laborat. d. Polytechnikums, Cöthen, May, 1907.)—Measurements were made, with an alternating current and a very sensitive telephone, of the resistance of solutions of salts of nickel, iron, copper, and other metals, these being contained in a vessel placed perpendicular to the lines of force. The field of 3,000 Gauss was produced by a horseshoe electromagnet, with square-ended pole-pieces 16 mm. apart, and the electrolyte was kept at constant temperature by means of boiling ether. A negative result was obtained, the change of resistance due to the magnetic field being less than $\frac{1}{150}$ per cent. (with Bi, less than $\frac{1}{15}$ per cent.). G. E. A.

1398. *Electrical Conductivity in Dilute Amalgams.* **F. Skaupy.** (Zeitschr. Phys. Chem. 58. pp. 560–566, March 28, 1907.)—If for an amalgam, c is the number of gm.-equivalents per 100 gm. of mercury, L the conductivity of the amalgam at 18° compared with that of mercury at the same temperature, and $\lambda = (L - 1)/c$, then $\lambda^2 c/\lambda_\infty(\lambda_\infty - \lambda)$ has constant values for different dilutions in the case of amalgams of tin, of lead, of bismuth, of silver, and of gold; for zinc and for cadmium amalgams the values increase rapidly with increasing strength of the amalgam. The equivalent conductivity at infinite dilution is nearly the same ($\lambda_\infty = 0{\cdot}8$) for different metals dissolved in mercury—bismuth is an exception, unless it be considered univalent. The above conclusions were established empirically from the experimental data already available; they can also be based on certain assumptions, viz., (1) the substances that show metallic conduction are partly dissociated into positive metal-ions and negative electrons; (2) metallic conduction depends chiefly on the rapidly-moving electrons rather than on the slow metal-ions; (3) the splitting up of neutral molecules into ions and electrons is in accord with the law of mass action; (4) the metal dissolves in the mercury in the diatomic condition, but chiefly dissociates into simple atoms, ions, and electrons. D. H. J.

1399. *Influence of Irradiation on the Electrical Conductivity of Antimonite.* **F. M. Jaeger.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 724–730, March 6, 1907. Proc., 9. pp. 809–814, May 24, 1907.)—While measuring the resistance of a sample of antimonite in different directions, it was noticed that light caused a great alteration in the amount of current passing. In some cases the conductivity increased by over 200 per cent. by exposing the substance to the light from an incandescent lamp. If a thick sheet of colourless plate-glass is interposed between the lamp and the substance the conductivity is increased still further. Hence rise of temperature has an influence directly opposed to light radiations. If glass plates of different colours are used it is found that the increase of conductivity with red light is large, for yellow larger, for green very small, for violet light again large, and there is again a minimum in the ultra-violet. R. S. W.

1400. *The Lorenz Apparatus.* **E. B. Rosa.** (Bureau of Standards, Bull. 3. pp. 209–236, May, 1907.)—The author finds a new formula for the mutual inductance between a circle and a coaxial helix. J. V. Jones gives two formulæ in terms of complete and incomplete elliptic integrals, but making numerical calculations by them is extremely tedious and laborious. The new formula is first deduced from considerations in connection with the potential of a uniformly magnetised circular disc. It is also deduced from a very general formula given by A. Gray [*Absolute Measurements*, Vol. II., Part I., p. 274]. The first terms of the formula can also be at once deduced from Searle and Airey's formula [see Abstract No. 158 (1906)]. The effect of the thickness of the disc is considered, and it is shown that it is appreciable. The complete equation for the Gray electrodynamometer is found, and a description and calculation of the constant for the Ayrton-Jones electrodynamometer is given. The author tests his new formula by applying it to cases which have already been worked out by Jones's formula. The results obtained are practically identical to about one in a million. The calculation is very much easier by the new formula. Finally, the assumption as to the equivalence of a spiral winding and a current sheet is discussed. It is proved that a winding of flat tape of any width, having the same pitch and number of turns, will have the same mutual inductance with respect to any coaxial circle as a winding of very fine wire, provided that the current begins and ends on the bounding planes of the cylinder. A. R.

1401. *The Exact Formula for the Mutual Inductance of Coaxial Solenoids.* **L. Cohen.** (Bureau of Standards, Bull. 3. pp. 295–308, May, 1907.)—Coffin [Abstract No. 1906 (1906)] quoted a formula for the mutual inductance of two coaxial solenoids, which he attributed to Kirchhoff. The author, having found by trial that the formula gave obviously erroneous results, was led to investigate where it was wrong. Using a method suggested by Himstedt, the complete solution of the problem is obtained in terms of complete and incomplete elliptic integrals. The formula agrees with the elliptic integral formula given by Russell [see Abstract No. 1210 (1907)], when an algebraical slip in the latter's formula, as printed in the *Phil. Mag.*, is corrected. A. R.

1402. *Mutual Inductance of Coaxial Solenoids.* **E. B. Rosa** and **L. Cohen.** (Bureau of Standards, Bull. 3. pp. 305–324, May, 1907.)—The authors first give a complete proof of Maxwell's formula for the mutual inductance between concentric coaxial solenoids of equal length. They then deduce Ròiti's formula very simply by means of Maxwell's equations. The formulæ of Gray, Searle, Himstedt, and Cohen [see preceding Abstract] are discussed. Cohen's formula is very laborious to evaluate, but it is useful in the special cases where the other formulæ converge slowly, and when it is necessary to test their accuracy. The authors point out that Russell has made an algebraical slip in his elliptic integral formula [see Abstract No. 1210 (1907)], having written k^2 for k^4 in the elementary formula utilised in the last line of his proof. Correcting this slip, they find that his result is identical with Cohen's. They state that Russell's series formula [although convergent in all cases] is sometimes laborious to evaluate. They recalculate by this formula the numerical example taken from Searle's paper, which Russell gives. Correcting a numerical error, taking two more terms and going to an extra decimal place, they find that the answer should be 0·00119989 instead of 0·0011995. This proves that in the case considered the accuracy of Searle's formula, even when only three terms are taken, is of a very high order. A. R.

1403. *Compensated Two-Circuit Electrodynamometer.* **E. B. Rosa.** (Bureau of Standards, Bull. 3. pp. 43–58, April, 1907.)—This paper gives the theory and description of some two-circuit electrodynamometers, with standarised shunts, built at the Bureau of Standards and used for measuring alternating currents. When the instruments are compensated for the resultant inductance and capacity of the moving-coil circuit, they have the same constant for alternating current as for direct, and may therefore be calibrated by direct currents. The author first shows that in an instrument in which the self-inductance of the moving-coil circuit and the mutual inductance of the two circuits are both zero, while eddy currents in the region of the moving coils, and capacity in the resistance, are supposed absent, the reading is independent of the self-inductance of the shunt. The effect of the self-inductance of the potential circuit and the mutual inductance between the two circuits are next considered. The former is compensated by a capacity, so as to make the potential current have the same phase as the impressed e.m.f. in the potential circuit. The circuit includes a resistance in parallel with which the condenser is placed, and the two terminals are joined to the same point on the shunt, so that no e.m.f. is impressed upon the potential circuit, except that due to mutual inductance. If the moving coils are so placed that the mutual inductance changes sign as the coils are deflected over the range of the scale, the torque will reverse sign also. In an instrument with a torsion head the position can be so chosen that the torque due to mutual inductance shall be zero. In a deflection instrument this is not practicable, but the torque may be made zero by compensating with capacity so as to have the same effect as reducing the self-inductance of the potential circuit to zero. If there are eddy currents, the torque due to them may be made zero by inserting a coil of a few turns in series with the moving-coil circuit and placing it in a particular position with respect to the fixed coil. The adjustment holds for all positions of the moving coils and for all values and frequencies of the current. F. E. S.

1404. *Torsion Electrometer.* **E. Salmon.** (Journ. de Physique, 6. pp. 551–559, July, 1907.)—This is a guard-ring electrometer the small disc of which is supported in a vertical plane by a light rod fixed normally to it. The rod is bent at right angles and it and the disc are suspended from a silver wire which can be twisted by a torsion head. An adjustable mass is also supported by the rod and acts as a counterpoise to the disc. Any attraction or repulsion of the small disc to or from the large plate of the electrometer thus produces a twist on the silver wire, and the restoration of the disc to its normal position necessitates an opposing torsion on the wire which is a measure of the attractive force. The play of the disc is limited by threads of silk stretched on the internal surface of the guard ring, and the motion of the large plate is controlled by a micrometer. The electrometer permits of measuring very high potentials with an accuracy of about 1 in 100.

F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

1405. *The Magnetism of Ships.* **W. Bartling.** (Elect. Engin. 39. pp. 753–755, May 31, 1907. Paper read before the N.E. Coast Inst. of Engin. and Shipbuilders, May 24, 1907.)—During the building of a cargo steamer measurements were made to find how the intensity of the field inside the hulk varied. From the experimental point of view the circumstances were very favourable. Owing to a strike of the riveters the whole ship was completely plated and all bulkheads and decks built in, while only about 5 per cent. of the rivets were fixed. The first measurement was made ten weeks after the double bottom was built and riveted. It showed that the effect of the ship's magnetism was only about one-quarter that due to the earth. Its horizontal component was almost opposite to the direction of the earth's horizontal field (the building berth lies S. 58·3 deg. E.) and its vertical component was one-third of that due to the earth and acted in the same direction. A month later, when 40 per cent. of the riveting was finished, the ship's magnetism had increased by 34 per cent., and a fortnight later, when 60 per cent. of the riveting was finished, the magnetism had increased proportionally. The steel structure of the flying bridge was built separately and was lifted into position by two cranes. Its magnetic poles were luckily so situated that they opposed the magnetism of the hulk. When the ship was ready for launching the strength of the field due to its magnetism was 57 per cent. of that of the earth's field. After launching it was swung and placed as near as the local conditions would permit in the opposite direction. The ship's magnetism then progressively diminished, until after 20 days it was only 15 per cent. of that due to the earth. The magnetic conditions proved to be very satisfactory for both the compasses on the flying bridge. The vessel went to sea without a compensating magnet for the standard compass, and with only one compensating magnet for the steering compass. The deviation of the standard compass after the trial trip was N. = + 5 deg. (E.), E = + 70 deg. (E.). A second ship, practically a duplicate of the first, was built on the same building slip in nearly the same length of time, but the vessel was not swung so as to lie in the opposite direction to that in which she had been built after the launch during the completion and outfit. The ship's magnetism was consequently much greater than in the preceding case. Seven compensating magnets had to be put in the compass, considerably weakening the field in which the needles swung, which is very objectionable in practice. The magnetic conditions under which the compasses worked in the second ship were much worse, even although all the rails within 10 ft. of the compasses had been made of brass and teak. In the author's opinion the simplest and best solution of the compass problem is to use plates of a non-magnetic iron alloy for building the ship. The author has used non-magnetic nickel steel in the vicinity of the standard compass with good results. A. R.

1406. *Magnetic Properties of Heusler's Alloys.* **J. C. McLennan.** (Phys. Rev. 24. pp. 449–473, June, 1907.)—Four different alloys were made, the percentages used being as follows :—

Number of Alloy.	Aluminium.	Manganese.	Copper.
I.	8·0	32·1	59·8
II.	9·7	25·6	64·6
III.	14·3	28·6	57·1
IV.	15·9	23·9	60·3

In each casting sufficient material was used to make two cylindrical rods about 20 cm. long and 0·8 cm. in diam., as well as 2 rings about 7 cm. in diam.

and 2·5 cm. in height. The magnetostriction in the alloys was investigated by Dawes. He found that when a change was made in the magnetising force to which the bar was subjected an almost instantaneous change of length occurred. As the magnetising force altered there was an hysteresis or lagging effect in the change of the length of the bar. When the specimen was left in the field for some time there was a continuous shortening of its length. The maximum elongation was obtained with No. III. alloy. It was sixteen ten-millionths, or about one-third the maximum for iron. Further experiments by McTaggart and Robertson show that the structure of the alloys when freshly cast is very unstable, and that it undergoes a rapid change under repeated magnetisations and a slower change under the lapse of time. Miss L. B. Johnson measured the permeability of the rings by a similar method to that employed by Ewing and Klaassen. The alloys I. and II. were feebly magnetic and alloy III. only slightly magnetic. Alloy IV. had the highest permeability, one of the rings giving the following results :—

H.	B.	μ.	H.	B.	μ.
0·0379	3·108	82·0	16·45	1367	83·0
0·147	13·67	92·9	27·14	2113	77·8
0·452	49·72	110·0	34·55	2258	65·4
1·192	136·75	114·7	41·77	2424	58·0
2·467	279·72	113·3	51·00	2548	49·8
3·331	360·52	108·2	55·93	2586	44·4
5·264	535·81	101·7	80·61	2735	33·8
7·81	739·70	94·7	92·13	2735	24·6

Measurements were also made on the changes in the permeability produced by continued heating. The results showed that the permeabilities of the alloys could be considerably increased by continued heating. No. IV. alloy when cooled from the melting-point possessed a permeability very much higher than that which it had when cooled from a red heat. A. R.

1407. *Solar Activity and Magnetic Variations.* **P. Cirera and Balcelli.** (Comptes Rendus, 144. pp. 959–961, May 6, 1907.)—Notable variations of the magnetic elements and earth currents have been noted at the Observatory of Tortosa during the first quarter of 1907. Comparison of the times of their occurrence with the state of solar activity at the same epoch suggests a close relation between the phenomena. The magnetic variations coincided with (1) the appearance of a large region of activity at the sun's east limb ; (2) the passage of an active region over the central meridian ; (3) large increase of any active area near the central meridian. C. P. B.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

1408. *The Law Governing the Hæmolytic Action of the Rays of Becquerel.* **C.-J. Salomonsen** and **G. Dreyer.** (Comptes Rendus, 144. pp. 999–1001, May 6, 1907.)—Human blood diluted with 99 parts of a 0·9 per cent. solution of NaCl is placed in a Zeiss-Thoma hæmocytometer and then exposed to the action of radium rays. After the removal of the radium at the end of 1 hour and 80 min. a count is made of the red cells and this is repeated at intervals. The analysis of the figures obtained shows that the destruction of the cells takes place in such a manner that the results may be expressed by the same differential formula as that which applies to monomolecular reactions, viz., $dx/dt = K(a - x)$. H. W. P. Y.

REFERENCES.

1409. *Integration of the Lorentz-Poincaré Potential Equations.* **A. Schidlof.** (Phys. Zeitschr. 8. pp. 431–433, July 1, 1907.)—Deals with the integration of the expressions used by Lorentz and Poincaré in the electron theory for the scalar and vector potentials. E. H. B.

1410. *Influence of Dispersion and Selective Absorption on Diffraction.* **M. Laue.** (Phys. Zeitschr. 8. pp. 446–448, July 1, 1907.)—A mathematical paper based on Maxwell's theory and equations. [See also Abstracts Nos. 134 and 1294 (1906).] E. H. B.

1411. *Action of a Dielectric Cylinder on Electric Waves.* **C. Schaefer.** (Ann. d. Physik, 23. 1. pp. 163–175, May 28, 1907. Phys. Inst. d. Univ., Breslau, March, 1907.)—A highly analytical paper dealing with the theory of Laugwitz's experiments [see Abstract No. 1390 (1907)] for different values of the dielectric constant and extinction coefficient. E. H. B.

1412. *Röntgen, Kathode, and Positive Rays.* **J. J. Thomson.** (Engineering, 83. p. 246, Feb. 22; 281–282, March 1; 316–317, March 8; 353–354, March 15; 387–388, March 22, and pp. 423–424, March 29, 1907. Electrician, 58. pp. 977–979, April 5, and pp. 1016–1018, April 12, 1907. Abstract. Lectures delivered at the Royal Institution.)—The whole range of the subject is briefly reviewed, and special attention given to explanations of recent results, for which the original pages should be referred to. The experiments shown in illustration at the lectures are also described. L. H. W.

1413. *Electrically-actuated Flame Changes.* **K. Marbe.** (Phys. Zeitschr. 8. pp. 415–416, June 15, 1907. From the Psycholog. Inst. d. Akad., Frankfurt.)—By his method of smoke-traces of flames the author demonstrates changes in the flame consequent upon changing its electric potential, whether by closing a circuit or using the town alternating-current supply. E. H. B.

1414. *Magnetic Induction in Ellipsoids of Rotation placed in a Homogeneous Field.* **O. Grotian.** (Ann. d. Physik, 23. 3. pp. 575–590, July 5, 1907.)—A theoretical paper in which it is attempted to apply the approximation method of Murphy. L. H. W.

1415. *Law of Magnetic Distribution at Fixed Epoch.* **E. Mathias.** (Annal. Chim. Phys. 11. pp. 5–68, May, 1907.)—The paper gives the results of a general discussion of the law of regular distribution of the magnetic elements of any country at a fixed epoch. The works of Rucker and Thorpe, Moureaux, Paulsen, and Liznar are reviewed, and a formula presented for representing the general distribution law found by practice. The accuracy of this is then tested by application to certain districts included in the French magnetic survey, and a discussion of the anomalies encountered. C. P. B.

1416. *Superposition of Mechanical Vibrations (Electric Oscillations) upon Magnetisation, and Conversely.* **J. Russell.** (Electrician, 59. pp. 480–482, July 5, 1907. Abstract.)—[For original paper see Abstract No. 716 (1907).]

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1417. *Density Curve of Mixtures of Bromine and Chlorine.* **L. W. Andrews** and **H. A. Carlton.** (Amer. Chem. Soc., Journ. 29. pp. 688–692, May, 1907. Contribution from the Lab. of the Mallinckrodt Chemical Works.)—The authors' measurements give the number 3·10227 as the most probable value for the density of pure bromine at 25°/4°. The apparent coefficient of expansion of bromine in glass between 25° and 30° is 0·00110. The above density and that of chlorine previously obtained indicate that the relation of the percentage of chlorine p in a mixture of the two elements to the density d at 25° should be expressed by $p = 82{\cdot}005\,(3{\cdot}10227/d - 1)$, assuming that no contraction occurs on mixing. The observed densities of such mixtures are, however, found to be given by the expression $p = 88{\cdot}593\,(3{\cdot}10227/d - 1)$, or, when the mixture is saturated with water, by the approximate formula, $p = 88{\cdot}59\,(3{\cdot}1004/d - 1)$. T. H. P.

1418. *Compounds of Silicon and Molybdenum. Molybdenum Bi-silicide.* **E. Defacqz.** (Comptes Rendus, 144. pp. 1424–1427, June 24, 1907.)—$MoSi_2$ is prepared by heating in the electric furnace a mixture of copper silicide with amorphous Mo obtained by the reduction of the oxide by hydrogen. The heating is continued for 100 sec. under 800 to 900 amps. Mo forms a number of silicides. It is difficult to free them from Al when produced by the aluminothermic method. [See also Abstract No. 1100 (1907).] F. R.

1419. *Borides of Iron.* **B. du Jassonneix.** (Comptes Rendus, 145. pp. 121–123, July 8, 1907.)—By heating together, in the electric furnace, in a current of hydrogen, mixtures of B and Fe in varying proportions, two definite compounds have been prepared corresponding to the formulæ Fe_2B and FeB_2. The former crystallises in long prisms of a steely-grey colour, having a density at 18° C. of 7·37; the latter, which represents the limit of combination of Fe with B in presence of carbon, is obtained as a fused mass, very hard and friable, and having a density at 18° of 5. W. H. Sr.

1420. *Nickel-Tin Alloys.* **E. Vigouroux.** (Comptes Rendus, 144. pp. 1351–1353, June 17, 1907.)—The author has examined, by practically only chemical means, some Ni-Sn alloys, and finds that only those containing up to about 40 per cent. Sn are magnetic (feebly), and that these upon treatment with nitric acid and potash leave a residue corresponding to the formula Ni_3Sn. This substance is non-magnetic. F. R.

1421. *Cobalt-Tin Alloys.* **F. Ducelliez.** (Comptes Rendus, 144. pp. 1432–1434, June 24, 1907.)—From a chemical examination of some Co-Sn alloys it is concluded that the compound CoSn is formed, which is a powder of density 8·950. A mixture of Co and Sn in the proportions of the formula CoSn, heated to low red in an atmosphere of hydrogen, combines with incandescence. F. R.

1422. *Chill Cast Iron.* **H. Wedding** and **F. Cremer.** (Stahl u. Eisen, 27. pp. 833–838, June 12, and pp. 866–870, June 19, 1907.)—The experimental results included in this paper refer to chemical and microscopic examination of a series of irons cast with different depths of chill, and also the types of cooling curves obtained at different rates of cooling of cast iron through solidification. The general results follow. A line A*a′* is suggested in the iron-carbon equilibrium diagram, running from A, the solidification of pure iron to *a′* — 2·7 per cent. carbon, 1,120° C., representing the fact that in white cast-iron the carbon-content of the first separating, carbon-saturated mixed crystals is greater than in grey cast-iron of the same total carbon. The composition of the mixed crystals is a function of the rate of cooling. If the cooling be slow enough to produce a grey iron, further decrease in the rate of cooling does not affect the structure generally, but only the fineness of the graphite. The general type of crystallisation in white iron, tending to the form of long strings of crystallites, is characteristic of rapid crystallisation such as occurs from a supercooled liquid; and it is taken that supercooling is the essential feature in the formation of white iron. The evolution of heat upon solidification, which was found to be accompanied by 100° rise of temperature, is interpreted as a supercooling effect. Grey iron solidifies in a much narrower range of temperature, and the structure has no peculiarities suggesting supercooling. F. R.

1423. *Melting-point of Eutectic Mixtures.* **C. Benedicks and R. Arpi.** (Metallurgie, 4. pp. 416–419, June 22, 1907. Chem. Universitätslaborat., Upsala.)—It is inferred, from the results of determinations of the melting-point of mixtures of powders, of known sizes of grain, of Pb and Sn, in the eutectic proportions, (*a*) that the greater the average size of grains of the components of a eutectic mixture the higher is the melting-point of the mixture, and (*b*) that increase of the size of the grains of the component which occurs in smaller proportion in the eutectic has greater effect in raising the melting-point than increase of the size of grains of the other component. These results are then applied to explain peculiarities in published data, *e.g.*, Goerens found that a grey pig-iron which solidified at 1,130° C. had after slow cooling a melting-point of about 1,200°. The graphite occurred mostly in large flakes. The melting-point of a solidified eutectic should further be a function of the time during which it has been held at a temperature slightly below that of its solidification; and the less the mutual solubility of the components the greater will be the effect of such heating. F. R.

1424. *Shape of Melting-point Curves in Binary Systems.* **R. Ruer.** (Zeitschr. Phys. Chem. 59. pp. 1–16, April 23, 1907. Inst. f. anorg. Chemie, Göttingen.)—The author shows theoretically that, in a binary system forming a solid and a liquid phase, the two phases have the same composition for all, and only for all concentrations at which the tangent to the freezing-point curve is parallel to the axis of concentration. In addition to the three types of freezing-point curve given by Roozeboom [Abstract No. 678 (1900)] for cases where the two components form a continuous series of mixed crystals, the author indicates the possible existence of a fourth type exhibiting a point of inflection. The curves for the systems Br + I [Terwogt, Abstract No. 1000 (1906)] and Mg + Cd [Grube, Abstract No. 976 (1906)] are regarded as belonging to this type. T. H. P.

1425. *Conductivity of Aqueous Solutions of Sodium Chloride and Sodium Carbonate.* **A. Wassmuth.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 985–1004, July, 1906.)—The electrical conductivity of blood may be regarded as that of an aqueous solution of sodium chloride and carbonate together with 7 to 8 per cent. of albumen, the effect of which is to reduce the conductivity by about 2·5 per cent. per 1 per cent. of albumen. In the present paper are given values for the electrical conductivity of mixtures of the chloride and carbonate, which are compared with values deduced by means of the law of mass action. An approximate agreement is noted, but it is pointed out that no more than this is to be expected if the ions are surrounded by a "watery atmosphere" (Kohlrausch), the dimensions of which are variable with the concentration (Biltz, Bousfield). T. M. L.

1426. *Equilibrium in the Deacon Process.* **K. V. v. Falckenstein.** (Zeitschr. Phys. Chem. 59. pp. 313–335, May 14, 1907.)—From the results of measurements (1) of the e.m.f. of the chlorine-oxyhydrogen element at ordinary temperature and (2) of the dissociation of hydrogen chloride and of water vapour at temperatures above 1,400° the author derives the expression: $\log K = 5750/T - 2{\cdot}136 \log T - 0{\cdot}000857T + 0{\cdot}683 \times 10^{-7} T^2 + 0{\cdot}296$, where $K = [H_2O]^2 . [Cl_2]^2/[O_2]^2 . [HCl]^4$, $[H_2O]$, &c., representing the partial pressure of the various vapours or gases. T. H. P.

1427. *Dissociation of Sulphuric Acid and Arsenic Acid.* **R. Luther.** (Zeitschr. Elektrochem. 13. pp. 294–297, June 7, 1907.)—Dissociated sulphuric acid should, according to Drucker, not contain any HSO_4' ion, while McBain pointed out that Drucker's values would remain unchanged if we assumed, with Kohlrausch and Holborn, a two-stage dissociation—

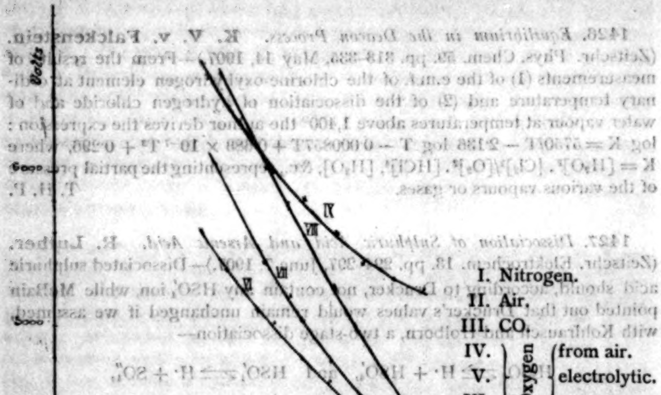
$$H_2SO_4 \rightleftarrows H^{\cdot} + HSO_4', \quad \text{and} \quad HSO_4' \rightleftarrows H^{\cdot} + SO_4'',$$

and if we assigned to HSO_4' half the mobility of SO_4''. An examination by the author of the various determinations [by Loomis, Wildermann, Kohlrausch, Jones and Douglas, Barth ($KHSO_4$ and $NaHSO_4$)] supports this view, and yields for sulphuric acid the dissociation constant 0·013. Similarly Walden's data yield for the dissociation constant of arsenic acid the value 0·005. H. B.

1428. *Validity of the Law of Mass Action for the Combustion of Nitrogen in the High-tension Flame.* **W. Nüranen.** (Zeitschr. Elektrochem. 13. pp. 297–305, June 7, 1907. Extract of Dissertation, Karlsruhe. Communicated by **M. Le Blanc.**)—Following the experiments of Brode [Abstract No. 624 (1906)], the author investigates whether the law of mass action is applicable to the combustion of nitrogen in the high-tension arc flame. He finds that it is, provided that the arc, *i.e.*, the temperature gradient, is kept constant, and he shows that it should be so for a monomolecular reaction; the case of a bimolecular reaction is left open. A current of constant pressure does not sustain an arc, because any slight fall in the current intensity would lead to a progressive fall in the temperature. The bulb was therefore placed, with choking coils in series, in the secondary of a transformer whose primary was fed with alternating currents at 120 volts, 50 cycles, and which contained a lamp resistance. One of the two platinum electrodes was fastened to a brass rod moving with a screw thread in a copper sleeve ground into the bulb; thus the arc length could be adjusted; the bulb was not perfectly gas-tight. The arc itself played between two Nernst tubes, wound with platinum wire and attached to the platinum electrodes mentioned. The NO formed was absorbed by sulphuric acid of 98 per cent.—later replaced by acid of

70 per cent. as more suitable, as Tower had also observed—or by caustic potash. Some experiments have also been made with arc electrodes of carbon and of fluorspar, as proposed by Siemens, of Charlottenburg; but hardly any NO was obtained then. **H. B.**

1429. *Behaviour of the Electric Arc in Certain Gases.* **A. Grau and F. Russ.** (Zeitschr. Elektrochem. 13. pp. 345–348, June 21, 1907. Technolog. Gewerbe-Museum, Wien, May, 1907.)—This investigation is a continuation of



the authors' earlier research upon the behaviour of the electric arc in air. [See Abstract No. 1251 (1907).] The apparatus employed was similar to that used in the earlier investigation with two minor alterations. The following gases were used in the experiments: (1) nitrogen, (2) air, (3) carbon monoxide, (4) oxygen (from air), (5) electrolytic oxygen, (6) pure oxygen, (7) carbonic acid (commercial), (8) carbonic acid (pure), (9) electrolytic hydrogen, (10) sulphur dioxide. The gases were taken from pressure cylinders, and were dried over sulphuric acid and phosphorus pentoxide before passing into the apparatus—the pure oxygen, CO_2 and CO being the only exceptions in this respect. The gases were passed through the arc at a slow velocity, and the conditions necessary to maintain an arc 5 cm. in length in each gas were noted. The results are shown graphically in the Fig. The curves show that, with similar current densities, great differences in the e.m.f. required to form and maintain an arc 5 cm. in length exist among these gases, and that they may be arranged in the following order of increasing e.m.f.: Nitrogen, air, CO, SO_2, oxygen, CO_2, and hydrogen. The curves IV., V., and VI. show that small amounts of impurity in the oxygen cause marked differences in the e.m.f., while curves VII. and VIII. show similar variations in the case of CO_2. The authors suggest that this method may be useful for determining the purity of gases, but they state in closing their paper that more measurements will have to be recorded before the method can be considered a reliable one. The optical appearance of the arc in each gas was also recorded by the authors. J. B. C. K.

1430. *Electrolysis of Aqueous Solutions of Sodium Nitrate by Alternating Currents.* **C. Couchet** and **W. Chauffat.** (Zeitschr. Elektrochem. 13. pp. 410–418, July 12, 1907.)—The electrolysis is made with electrodes of different materials, 2 cm. wide, 1 mm. thick, a length of 4 cm. dipping into the solution. In most cases old, already used electrodes give better results than fresh electrodes, which latter are first oxidised by the nitrate; in the case of Cd, new and old electrodes give the same high yields. With currents of 2 amps. in solutions of 0·5 per cent. the yields of nitrite rise after one hour in the order Cu (8·12 per cent.), Al, Zn, Pb, Cd (28·88 per cent.); for the soda yields the order is different: Cu (0·15 per cent.), Ag, Pb (1·88 per cent.), Al (5·5), Zn (10·72), Cd (16·9 per cent.). The yields improve with higher current density, partly owing to the rise of temperature, and are best for nitrate concentrations ranging from 8·6 to 6 per cent.; with a frequency of 47 higher yields are realised than with frequencies of 11, 22, 55 periods. H. B.

1431. *Electrolytic Oxidation of Platinum.* **C. Marie.** (Comptes Rendus, 145. pp. 117–118, July 8, 1907.)—In the electrolysis of normal solutions of H_2SO_4, HNO_3, H_3PO_4, HCl, or NaOH, with platinum electrodes, passing a current of 2 amps. for 12 hours, the anodes are found to undergo distinct superficial oxidation, electrodes having areas of 100, 40, 6, and 0·3 $cm.^2$ losing 0·8, 0·5, 0·25, and 0·1 mgm. respectively on subsequent treatment with a dilute solution of KI acidulated with HCl. The anodes gain slightly in weight during electrolysis, due to the fixation of oxygen; the film of oxide formed, which is insoluble in HNO_3 and only dissolves in HCl in the presence of iodide, disappearing immediately at a red heat. The kathodes do not appreciably change in weight. It is considered probable that platinum is also superficially oxidised by contact with solutions of oxidising agents in the cold, and experiments are being made to test this. W. H. Si.

1432. *Periodic Phenomena in the Electrolysis of Nickel Salts.* **A. Thiel** and **A. Windelschmidt.** (Zeitschr. Elektrochem. 13. pp. 317–325, June 14, 1907. Chem. Inst. d. Univ., Münster, April 15, 1907.)—The authors have continued their investigations of the periodic phenomena observed in the electrolysis of solutions of nickel salts [see Abstract No. 152 (1907)]. Under certain conditions, the electrolysis of the ordinary ammoniacal solutions used for the quantitative determination of Ni proceeds regularly at first, but as soon as the solution has become colourless and nearly all the Ni has been deposited, the periodic phenomena are observed, as indicated by the readings of the voltmeter and ammeter. Only the voltage was measured. The periods are at first of very small amplitude, but this increases as the electrolysis proceeds, the wave-length also increasing. The amplitude is generally 0·1–0·2 volt, but may be as great as 0·4 volt. The periodicity ceases as soon as all the Ni has been deposited. Rise in temperature has no influence on the amplitude but diminishes the length of the period. In oxalate solutions no periodicity is observed below a temperature of 50° C.; moreover, the phenomenon sets in when most of the Ni is still in solution, and in most cases ceases before all the metal has been deposited. The amplitude (0·1–0·8 volt) remains fairly constant as long as the periodicity lasts, and varies with the current strength. The authors consider the phenomenon to be due to the alternate formation and solution of nickelic hydrate at the anode, but their theory of the mechanism of the action is not yet complete. That it is an anode effect was shown by measurements of the electrode potentials; the kathode potential remained constant, while the anode potentials showed the same variations as were indicated on the voltmeter. [See Abstracts Nos. 163, 1745 (1901), 1828 (1905), and 202 (1906).] T. S. P.

1433. *Electrolytic Deposition of Zinc from Ammonium Oxalate Solution.* **A. Fischer.** (Zeitschr. Elektrochem. 13. pp. 361–362, June 28, 1907.)—In conjunction with G. Lambris the author has prepared large quantities of electrolytic nickel, the electrolyte used being nickel ammonium oxalate. A nickel anode was used and did not show the periodic alternations in voltage described by Thiel and Windelschmidt [see preceding Abstract], whereas with platinum anodes the phenomenon had been observed some years back. The author has also investigated the various methods for the electrolytic estimation of Ni; the lowest values were obtained with the method of Fresenius, and the highest with the oxalate method. Oettel's method gave intermediate values. Analysis of the carbon left after dissolving the nickel deposit in copper ammonium chloride gave 36·63 per cent. C and 10·55 per cent. H. T. S. P.

REFERENCES.

1434. *Taking Microphotographs of Crystallisation Phenomena by means of the Cinematograph.* **H. Siedentopf** and **E. Sommerfeldt.** (Zeitschr. Elektrochem. 13. pp. 325–326, June 14, 1907.)—A description of the application of the cinematograph to the taking of microphotographs of various crystallisation phenomena. A special crystallisation-microscope of Zeiss is used, in which the experimenter can observe the phenomena he wishes to photograph at the same time as the exposures are being made; by this arrangement a waste of film in the camera is avoided. T. S. P.

1435. *Connection between Abnormal Rise of Boiling-point of Dilute Solutions and Molecular Condition of the Solvent.* **J. J. van Laar.** (Zeitschr. Phys. Chem. 57. pp. 742–744, Feb. 12, 1907.)—The author considers Hunter's explanation of the abnormal rise in boiling-point when C_2H_4 is dissolved in liquid oxygen, namely, that the oxygen is associated to $(O_2)_3$; but it is pointed out that C_2H_6 in oxygen is normal, and the author considers that there are no grounds for the above assumption. H. H. F. H.